# EXHIBIT 8

To

DECLARATION OF ALEXANDER E. GASSER
IN SUPPORT OF
DEFENDANTS OPTREX'S, FUJIFILM'S, SAMSUNG SDI'S AND
CITIZEN'S RESPONSIVE MEMORANDUM OF LAW
IN SUPPORT OF THEIR PROPOSED CLAIM CONSTRUCTION

REDACTED

# EXHIBIT 9

**To**

**DECLARATION OF ALEXANDER E. GASSER**
**IN SUPPORT OF**
**DEFENDANTS OPTREX'S, FUJIFILM'S, SAMSUNG SDI'S AND CITIZEN'S RESPONSIVE MEMORANDUM OF LAW**
**IN SUPPORT OF THEIR PROPOSED CLAIM CONSTRUCTION**

**REDACTED**

# EXHIBIT 10

**To**

**DECLARATION OF ALEXANDER E. GASSER**
**IN SUPPORT OF**
**DEFENDANTS OPTREX'S, FUJIFILM'S, SAMSUNG SDI'S AND CITIZEN'S RESPONSIVE MEMORANDUM OF LAW IN SUPPORT OF THEIR PROPOSED CLAIM CONSTRUCTION**

# SEMINAR M-9:

# PRINCIPLES OF LCD BACKLIGHTING

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## Summary

This seminar will provide a technical overview of the important factors involved in the backlighting of LCDs. Numerous forms of lamps now are available with varying different characteristics. These will be reviewed and compared. Optical factors will be covered and related to space constraints. The spectral requirements, luminance levels, system efficacy, power requirements, lamp temperature, as well as other parameters affecting system performance will be discussed.

SID

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# NOTES

# Principles of LCD Backlighting

SID '93 Seminar

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This seminar outlines the technology involved in the backlighting of liquid crystal displays. It covers basic terminology, lighting requirements, lamp types and optical techniques. The material is aimed at persons who may be involved in the LCD industry but who do not necessarily have substantial knowledge of lighting technology.

## 1. Terminology

Definition of basic terms is essential for a good understanding and discussion of the subject. While illuminating engineering contains many terms and units, only a few are necessary for reference in LCD lighting work.

Lumen Output: This term usually refers to the performance of a lamp, and is its luminous output measured in lumens. This is normally used as a non-directional quantity, expressing the total lumens generated – it tells us nothing about the spatial distribution or intensity of the light rays in any particular direction.

Most commercially available lamps have a lumen output, or rated output, assigned by the manufacturer. This is the manufacturer's claimed lumen output for a statistically average lamp, operated under specified conditions of a rated current, voltage or wattage. Care must be used in design calculations to ensure that a proper lamp lumen output is used as this output can be affected by numerous factors. (See "Light Loss Factors").

Luminous Intensity:, or Candlepower. This term, measured in candelas, represents the concentration of light in a particular direction. Its strict definition is the limiting ratio of luminous flux to solid angle, or the lumens contained in an infinitesimal solid angle. Thus we can think of luminous intensity as the intensity of an individual light ray, or the intensity in a particular specified direction.

Luminance: is yet another measure of the quantity of light. It is the physical attribute of an object that creates brightness. Luminance is the ratio of luminous intensity to the size of the area producing the intensity. The metric term for luminance thus is candelas per square meter, (cd/sq.m.). In the English system, the unit is the footlambert (fL) which is officially deprecated but is still widely used.

1 Footlambert is the luminance of a perfectly diffuse surface which emits a total light output of 1 lumen per square foot. Mathematically, it can be shown that 1 fL = 3.24 cd/sq.m. (A perfectly diffuse surface is that which has a "Lambertian" light distribution, that is, its luminous intensity varies in proportion to the cosine of the angle from the perpendicular to the surface).

Luminous intensity defines the pattern of distribution of light from a lamp, but also can be used to describe the angular pattern of light emission from a surface. If the intensity distribution from the surface is in cosine form (Lambertian), then the luminance of the surface will be equal from all angles of view. For example, at an angle $\alpha$ from the perpendicular, or normal, to a surface:

$I_\alpha = I_0 \cos\alpha$ for a Lambertian surface

where $I_\alpha$ = luminous intensity at angle $\alpha$
where $I_0$ = luminous intensity emitted perpendicular to the surface

If $A_0$ represents the area of the emitting surface, then

$A_\alpha = A_0 \cos\alpha$

Therefore

$$L_\alpha = \frac{I_\alpha}{A_\alpha} = \frac{I_0 \cos\alpha}{A_0 \cos\alpha} = \frac{I_0}{A_0} \qquad (1)$$

Thus for a perfect diffuser, the luminance is constant for all angles of view. This point will be re-addressed when light control materials for LCD's are considered.

Reflectance: is the proportion of light incident on a surface which is reflected. For example, a reflectance of .80 indicates that 20% of the incident light is absorbed.

Reflectance may take virtually any form, varying from an ideal mirror, ie perfectly specular reflectance, to totally diffuse or Lambertian reflectance. Between these two extremes lie all practical surfaces which show a mixture of specularity and diffusion ("mixed reflectance"). The specular portion of the reflected light will be reflected at an angle from the normal, or perpendicular, which is equal to the angle of incidence. As the angle of incidence changes, so also therefore does the distribution of reflectance from a practical surface. The term BRDF, Bidirectional Reflectance Distribution Function, describes the entire pattern of light reflectance for a surface, and is dependent upon the angles of incidence (both azimuth and altitude) and the angles of reflectance (also azimuth and altitude). By measurement of the BRDF for a surface, the entire geometric light reflecting properties of the surface are known. BRDF is an important concept in the optical design of reflectors and is used extensively in software developed for such

purposes.

Transmittance: is the proportion of light incident upon a surface which is transmitted. Transmitting surfaces may be clear, where the direction of the emitted ray is identical to that of the incident ray, or perfectly diffuse, where the emitted light pattern is Lambertian no matter what the angle of incidence may be, or in between these two extremes. BTDF, Bidirectional Transmittance Distribution Function, has a definition equivalent to that described above for BRDF. The degree of diffusion created by a diffusing panel may be altered by changing the physical constituents which form the panel, or its thickness. In general, a large amount of diffusion (approaching Lambertian diffusion) is associated with low transmittance, while moderate diffusion usually allows higher transmittance.

Typical transmittance values for high resolution LCD systems are as follows:

| | |
|---|---|
| Active matrix, color | 2 to 4 % |
| Active matrix, color | 10 to 12 % |
| Passive matrix, color | 4 to 8 % |
| Passive matrix, color | 10 to 15 % |

Increased transmittance is produced with lower resolution systems.

## Spectral Transmittance

The transmittance of a material will be dependent on the wavelength composition of the incident light, unless the transmitting medium is neutral, that is, it possesses no characteristics which cause spectral change during the transmitting of the light. Materials which are grey or white generally cause little spectral alteration, and thus their transmittance does not change with the spectral power distribution (SPD) of the light source.

Materials which transmit light and are themselves colored have a spectral transmittance function, that is, their transmittance varies with wavelength. It will be apparent that a blue transmitting medium will have a high transmittance if the incident light has a high power output in the blue wavelength, yet a lower transmittance for light with a SPD showing high red output. This is of particular importance in backlighting of LCD's as the optical efficiency of the system can be affected strongly by the relationship between the SPD of the light source and the spectral transmittance characteristics of the liquid crystal display pixels.

Spectral transmittance curves for typical Red, Green and Blue LCD's used in color displays are illustrated in figure 1.1.

## Color Temprature

A "black body" radiator such as a filament will emit light when operating at high

temperatures, and the color of the emitted light will be dependent upon the temperature. Low temperature generation produces bias to the red end of the spectrum, while high temperature produces a bluish light. Color temperature, expressed in degrees Kelvin, therefore becomes a definition of the spectral distribution of a filament lamp.

This term also is widely applied to non-filament lamps, and in such cases is more correctly called "Correlated Color Temperature". This is the closest temperature on the black body locus (when plotted on the CIE chromaticity diagram) which is approached by the non-black body radiator. While this is a useful concept for general description of the color shade of a fluorescent or discharge lamp, the actual spectral power distribution (SPD) will differ radically from that of a black body source of the same color temperature. Also, there is an infinite number of SPD's which can produce any given correlated color temperature.

Field of View

is a term which generally describes the range of viewing angles under which a display may be observed. This is measured from the normal, or perpendicular, to the plane of the display. Field of view generally will be defined both horizontally and vertically from the normal.

Light Loss Factors (LLF)

For various reasons, the light output of a lighting system and the luminance of an LCD will reduce over time. Virtually all light sources exhibit lumen depreciation, or a reduction in light output with burning hours. This usually takes the form of a fairly rapid fall during approximately the first 100 hours of lamp operation, then with a gradual reduction to the end of life. Different forms of lamps have different lumen depreciation rates and therefore during lamp selection for a backlighting design, this factor should be addressed. Lamp manufacturers normally have lumen depreciation curves available for their products.

A further type of light loss factor is dirt depreciation. While this may be a small factor in clean environments, in many cases this can cause a 10 to 20% loss in luminance if the optical system is not kept clean.

Yet another form of LLF is "Ballast Factor". Fluorescent and other forms of gas discharge lamps require a current limiting device in the circuit to control the current supplied to each lamp. Lumen figures published by lamp manufacturers almost invariably apply to the lamp operated using an ideal, or "reference", ballast. This ballast creates the exact electrical characteristics for which the lamp is designed. Commercially available ballasts, however, frequently under-drive the lamps, operating them at reduced current and thus the lumen output produced may be less than expected. Proper lamp operation and verification of delivered light output is an important step in the selection of a lamp and the ballast type which will drive it.

## Lamp Life

All light sources have a life quoted by the manufacturers. However, it is important to recognize that this life is statistically determined and does not represent a guarantee of the life of a particular lamp. Different definitions of life are used by different manufacturers,but probably the most commonly used definition is the 50% failure point. ie The life of a lamp is defined as the statistical point at which 50% of an "average" batch of such lamps will fail. Thus many lamps will fail prior to the rated life period.

It will be apparent that in critical situations (avionic systems, for example), the practical life of the lamp may be considerably shorter than the rated life, as lamp changeout is necessary for safety reasons to reduce the premature failure in use.

Certain lamps have very long life but exhibit drastically reduced lumen maintenance late in life. Therefore there may be a practical end-of-life when the lamp has not extinguished but is producing such a reduced light output that it is no longer able to meet specifications for luminance level.

Claims of lamp life thus must be treated with caution, and analyzed along with lumen depreciation data and a recognition of the possible effects of premature lamp failure.

## 2. Specifications and Applications

Performance requirements vary widely depending upon the LCD application; the specifications for a display to be used in a high performance aircraft differ greatly from those for a lap-top computer. Examples of typical specifications are provided in table 2.1. Table 2.1A applies to a small display roughly 3 inches square while table 2.1B is for a larger display, approximately 11 x 7 inches. Luminance requirements vary in accordance with the application, with very high luminances required in situations where the LCD may be viewed under daylighting conditions.

Uniformity of luminance is generally expressed as a plus /minus value. However, no clear universal definition of the meaning of uniformity exists. While the plus/minus percentage value expresses the allowable departure from the mean luminance, the precise definition of maximum, minimum and mean is unclear. For backlighting systems using parallel fluorescent tubes, the maximum luminance is usually taken at a point directly in front of a tube, while the minimum is measured at an adjacent point between tubes. It will normally be found, however, that the true minimum lies at the corner of the LCD or along an edge of the display. The method of measuring adjacent maximum and minimum points is suitable method for characterizing uniformity in terms of a striping problem, but is not applicable to defining overall uniformity.

In defining average luminance, many manufacturers or designers measure a row of points across the center of the display. This ignores the normal luminance fall-off towards the less brightly lit edges.

More investigations and industry consideration is needed for the development of a standard method reporting LCD performance in terms of level and uniformity.

## 3. Fluorescent Lamp Characteristics

Most LCD backlighting systems in use today rely on one of a variety of systems using fluorescent lamps. These lamps work in a manner similar to conventional fluorescent lamps used in the general lighting of buildings, but have been miniaturized for LCD applications. Manufacturers who produce fluorescent lamps suitable for LCD lighting purposes are partially listed in table 3.1.

Figure 3.1 shows a view of a fluorescent lamp. The major components are the glass tube, end-electrodes and phosphor coating on the inside of the tube. The tube contains low pressure mercury gas and a small amount of inert gas to assist in lamp starting. Applying a high voltage across the electrodes causes ionization of the gas and a current flow is created between the two electrodes. This flow causes the gas to emit radiation, predominantly in the ultra-violet region (253.7 nm), which excites the phosphor on the inner walls of the tube. The phosphor emits light of wavelengths dependent on the type of phosphor used, usually over a broad band spectrum producing a generally white appearance.

### Spectral Power Distribution

By alteration of the chemical composition and mix of the phosphors, the spectral power distribution of the emitted light can be changed. "Cool" colors are produced by phosphors designed to emit a high proportion of blue light, while "warm" colors are generated by increased emission in the yellow and red spectral bands.

Considerable research has led to the development of much improved phosphors in recent years, both in their efficiency of conversion of ultra-violet radiation to visible light, and in the improvement of lamp color. For commercial applications involving the lighting of buildings, the rendition of the colors of objects in a realistic manner is important, and phosphors have been developed which produce SPD's which yield good color rendition. An example of these are the various tri-phosphor lamps produced by several manufacturers which show peaks in their SPD at three distinct points in the spectrum. The manipulation of SPD by phosphor design is an advanced science involving phosphor chemistry. There is much interest in the development of fluorescent lamp phosphors which shows peaks in the spectral regions close to the peak spectral transmittance values of color LCD's. By coordinating lamp spectral output with LCD spectral characteristics, considerable enhancement of system efficiency may be achieved. Lamps with enhanced spectral characteristics for LCD applications now are available. An idealized spectral output for lamps used in LCD backlighting is given in figure 3.2.

### Ballasts

As previously mentioned, electrical discharge through a gas must be controlled by

external electrical means otherwise a very high electrical current will flow which will burn out the lamp almost instantaneously. A ballast therefore is connected into the circuit which not only provides the high starting voltage needed for ionization, but immediately after starting, acts as a current limiting device. The current flow is controlled to be close to the design specification of the lamp for steady state operation.

Ballasts may be on one of two forms, magnetic or electronic. The magnetic ballast is a highly reactive transformer which creates a high voltage in its secondary coil to start the lamp, but which then limits the current flow due to its very high reactance. The electronic ballast achieves a similar result through the use of multiple electronic components.

Hot and Cold Cathode

Two general categories of fluorescent lamps are the hot cathode and cold cathode types. The hot cathode lamp uses electrodes which are small heater coils. A small voltage is applied across each coil from the ballast using a secondary circuit, such that the electrode is heated so as to emit thermally a large quantity of electrons. This is an efficient method of creating the electron flow through the tube, as the voltage drop at the cathode ("cathode fall") is only a few volts.

Cold cathode lamps do not have a coil formation, and have electrodes which consist of cylinders or plates. They exhibit a high cathode fall during operation, and thus are less efficient than hot cathode lamps.

Both hot and cold cathode lamps are being applied in LCD backlighting systems, but the characteristics of these two forms of fluorescent lamps are substantially different, each having its own advantages and disadvantages. The following summarizes some important differences:

Starting voltage

| | |
|---|---|
| Hot cathode: | Lower voltage |
| Cold cathode: | Higher voltage |

Life

| | |
|---|---|
| Hot cathode: | Shorter, 5,000–15,000 hours |
| Cold cathode: | Longer, 10,000–20,000 hours |

Vibration and Impact Resistance

| | |
|---|---|
| Hot cathode: | Poorer |
| Cold cathode: | Better |

Cathode Losses

| | | |
|---|---|---|
| Hot cathode | Low | (15 v) |
| Cold cathode | High | (150 v) |

Efficacy

| | |
|---|---|
| Hot cathode | Higher |
| Cold cathode | Lower |

Efficacy is dependant on numerous characteristics such as arc length, tube diameter, power loading (watts/cm), phosphor type, and lamp shape, in addition to the type of cathode. Complete performance specifications are available from various manufacturers, see table 3.2.

Temperature Characteristics

Fluorescent lamps are highly temperature sensitive in both their starting voltage characteristics and lumen output during operation. At low temperatures, the breakdown voltage required to start the lamp is high and ballasts designed for normal ambient temperature starting are likely to be unsatisfactory. Furthermore, at both low and high temperatures, fluorescent lamps give substantially reduced lumen output. The exact temperature characteristics are dependent upon the exact lamp type, and this factor must be checked prior to selection of lamps which must operate over a wide range of ambient temperatures. Supplemental heating circuits may be required.

Aperture Fluorescent Lamps

Normal fluorescent lamps emit light in all directions, with approximately equal intensity in directions perpendicular to the lamp surface. In certain applications such as edge lighting, discussed later, it is necessary to project light into a thin sheet of transmitting material. It may be advantageous for such applications to use an aperture or reflector fluorescent lamp, which is a modified lamp form creating a sharply increased intensity in a narrow range of directions. Figure 3.3.

Aperture lamps use a white reflective layer between the phosphor and glass tube covering most of the lamp perimeter. A small gap in the reflector and phosphor layer allows light to be emitted. Inter–reflection of light within the tube causes the output of light through the window to be much increased, up to 10 times that of a non–reflectorized lamp. The light projected into an edge lighting system thus can be increased.

## 4. Other Light Source Types

Although much less widely used or investigated than fluorescent lamps, several other lamp types which have received broad usage in other applications are worthy of note. Possible future innovations may make other sources practical alternatives to fluorescent backlighting.

Incandescent/Quartz-halogen Lamps

Lamps using incandescent filaments have very low efficacy (lumens per watt, lpw) ranging generally in the order of 10 to 20 lpw. They continue to be used widely for general lighting primarily because of their low cost. However, they have two further advantages, as they are dimmed easily by reduction of voltage and they are available in highly compact form. This compactness is a considerable advantage when very precise optical control is required.

A variety of incandescent lamp which is widely applied is the quartz-halogen lamp. This is a miniature incandescent lamp with a halogen gas filling. During lamp operation, tungsten atoms which escape from the filament combine with the halogen atoms to form a tungsten halogen. Upon striking the hot filament, the tungsten halogen molecule breaks down into tungsten and halogen gas, thereby creating a regenerative cycle. The filament life is extended, and the filament also can be operated at higher temperature which produces increased efficacy. To withstand the high temperature operation, the use of glass is not possible, and thus quartz is substituted.

Recent innovations have allowed a heat-reflecting coating to be placed on the quartz envelope. This reflects energy back into the lamp to maintain high temperature, energy which otherwise would have been lost, thereby contributing to further increased efficacy up to approximately 25 lpw.

Filament lamps have their application for scientific purposes primarily where precision optical control is required, such as beaming light into the collection end of a fiber optics bundle.

High Intensity Discharge Lamps

This general category of lamps, known as HID, includes mercury, metal halide, and sodium lamps. Their principle is the passage of current through an ionized gas contained in a discharge tube. Unlike fluorescent lamps, however, the higher vapor pressure used in HID lamps causes the output to lie primarily in the visible band, with little output in the ultra-violet region. Like fluorescent lamps, HID lamps require a high starting voltage and a current limiting ballast. They do not exhibit the temperature dependency of fluorescent lamps, which is an important advantage.

A characteristic of HID lamps that has been a disadvantage in many applications in that the lamp must be cold in order to start up. If voltage is switched off momentarily during normal operation, the lamp will extinguish but will not relight until the arc tube has cooled off to allow the vapor pressure to reduce to its nominal cold state. This may be a period of several minutes. "Hot restrike" capabilities now are available for many HID lamps, however, where a very high voltage can be applied to cause ignition even under hot conditions.

Sodium lamps offer the highest efficacy of all HID lamps, up to 140 lpw for the high

pressure versions. Their pinkish-yellow color renders them unsuitable for any application involving color displays.

Mercury lamps, the bluish-white light seen in older highway lighting systems, are now falling into disuse. Metal halide lamps, a variety of mercury discharge lamp, is becoming predominant over mercury because of its substantially higher efficacy and excellent color properties. Metal halide lamps use primarily a mercury gas for the discharge, but rare earth salts are added to enhance color rendition, life and efficacy. The SPD of metal halide lamps can be controlled by the mix of salts, and to some extent, the SPD can be tailored to a given requirement by suitable blending of the contents of the discharge tube.

Metal halide lamps range in efficacy depending upon their wattage and compactness. A reduced efficacy normally accompanies a smaller arc tube length for equivalent wattage.

Metal halide lamps are not available in very low wattages. A 32 watt lamp has been developed, and when coupled with the very high-efficacy of metal halide sources in general, a high lumen output is produced. High output from a single lamp poses problems in LCD backlighting as the light generally must be spread out uniformly over an area. This generally requires greater depth than is available with most LCD systems, but metal halide sources have found application in LCD projection systems where the requirement for a thin backlight may not be significant. Wattages as high as 575 watts have been applied.

The arc tube size varies in metal halide lamps depending on the design. Commercial lamps used for general lighting have a relatively large arc, but numerous short arc versions are available. These are suitable for use in focusing optical systems as good optical control can be achieved by virtue of the compactness of the light producing area. Figure 4.1 shows the general construction of a short arc metal halide lamp.

An example of the short arc metal halide lamp is the HTI lamp. HTI lamps have a discharge vessel made of high quality quartz glass, in which the pure tungsten electrodes project from both sides. The current supply occurs through molybdenum pins, which are joined to the electrical connections of the lamp. To attain the necessary thermal drop between the hot discharge vessel and the connections, the "mofoils" must have a certain length. Because of the frosting of the lamp shafts, the HTI lamps can still be built rather short since a part of the radiation does not reflect within the lamp shafts to the lamp ends or bases and lead to heating there (light-guide effect). Instead, it is scattered and deflected through the frosted surface. The discharge vessel is filled with a base gas (argon) and mercury, as well as an exactly measured amount of halogenide from metals of the rare earths group, which essentially determines the light efficacy and color of the lamp.

HTI *reflector* lamps have a computer-calculated cold-light mirror similar to an

ellipse. It not only bundles the light from the discharge arc, but also reaches through mixing a very even illumination of an aperture (of an LCD light valve, for example) and a color temperature of approximately 5,600 K. The HTI 250 W/32 and HTI 400 W/24 lamps have been developed for demanding 8 and 16 mm projection, but also may be applied in projection LCD systems. The size of the aperture corresponds therefore to the diagonal of the respective Super-8 or 16 mm picture gate (approx. 7 mm or 12 mm). Reflector redesign will be necessary for larger LCD applications.

The metal halide lamps generate light in an electrical discharge arc, whereby the electrons emerging from the electrodes excite the gas and vaporous filling to give off light. Mercury alone does not give off the desired light. Other elements must therefore be added to complement the spectrum of the mercury in the desired ranges. The metals of the rare earths group have proven themselves for this purpose. Halogen compounds are filled into the lamp to more easily bring these into the necessary vaporous state. According to the temperature reached by the ignition of the fill gas (plasma) which is made to be electrically conductive, other chemical processes are responsible for the generation of light. Luminance and color temperature are thereby not equally distributed across the arc. Because of the alternating current operation, the electrons are alternately given off respectively by one of the electrodes, the hottest and brightest points of the arc constantly change position. The "hot spot" jumps back and forth between the electrode ends. Because of the short distance between the electrodes and the usual high operating frequency, this change is however insignificant for most applications. The given color temperature is a mean value over the entire arc. For the elliptical reflector lamps, the light given off by the "colder" and "hotter" part of the arc is so mixed, that the specified temperature is produced on the plane of the focal point in the surface of the illuminated aperture.

Some technical specifications of the Osram short-arc metal halide lamp are provided in table 4.1.

(Figures and information courtesy of Osram Sylvania Co.)

A partial listing of manufacturers of high intensity discharge lamps, including metal halide, is provided in table 4.2.

## 5. Light Control Systems

No matter what lamp type is employed, all LCD backlighting systems have the common requirement of producing relatively uniform luminance in a plane parallel to and behind the LCD. Numerous techniques have been developed, with more under investigation, to produce light control systems which approach the ideal flat sheet of light. A review of all developments is not possible, but some of the interesting and useful approaches are outlined below.

Flat Fluorescent Panel

Various techniques have been used to produce a fluorescent lamp which simulates a flat area source.

In its simplest form, lamps which are serpentine in shape have been widely used, creating in effect a row of parallel tubes, figure 5.1. The spacing between the tubes will affect the uniformity of the light, with a wide spacing producing unsatisfactory bands of high and low luminance. This may be overcome by the use of a diffuser between the lamp and LCD which evens out the luminance. For very good uniformity, a material which strongly diffuses the light is required, achieved either by a strong concentration of whitener in the material (generally plastic), or by the use of a thick diffuser. Transmittance of the diffuser generally is reduced if the diffusion is high, and thus there is a trade off between the uniformity achieved and the optical efficiency (and thus also the luminance level). Some details of diffuser materials are covered later.

Recently there have been developments of special forms of lamps operating on principles similar to the fluorescent tube, but which are different construction. One form of flat fluorescent lamp is similar to the bent serpentine lamp except that it is not actually a tube. Formed from a front and rear glass molding which are then joined together, a serpentine discharge path is created in a one piece lamp. Figure 5.2.

Another form of flat fluorescent lamp is based on the use of a sheet of plasma that activates the fluorescent phosphor, developing a good uniformity. These lamps are available in a variety of sizes up to 6 x 8 inches. Thickness is typically 0.40 inches or less.

Manufacturer's claims for the performance of flat fluorescent lamps vary depending upon the variety. A luminance of 20,000 cd/sq m (6000 fl.) has been claimed for a serpentine channel lamp, while the flat plasma lamps are stated to range between 3,500 and 10,000 cd/sq m (1000 and 3000 fl.).

Manufacturers who produce flat forms of fluorescent lamps are listed in table 5.1

Cathodoluminiscent Lamp

This form of lamp is also strictly fluorescent in that it consists of a flat panel of phosphor which is excited by radiation. Figure 5.3. However, in this case the excitation is created by an electron gun producing an electron cloud in a low field region. Near the lamp surface, a high electric field accelerates electrons into the phosphor screen. High luminance up to 34,000 cd/sq m (10,000 fl.) can be developed with good uniformity, and dimming capabilities can be provided. (Imaging and Sensing Technology Corp, Westinghouse Circle, Horseheads, NY 14845)

The disadvantage of this system is depth, needing approximately 3" for the overall package. A further disadvantage is high temperature and active cooling may be required

to maintain a faceplate temperature below 40 degrees c.

Electroluminescent Lamps

Electroluminescence is a technology which has been available for many years. The lamps consist of a flat plate onto which a dielectric-phosphor layer has been deposited. A second transparent dielectric is deposited over the first layer. An electric field placed across the two dielectrics will create luminescence in the phosphor, producing a uniform sheet of light. The primary disadvantage of electroluminscent layers is very low output, rendering them unsuitable for high luminance applications.

Edge Lighting Systems

Edgelight methods do not use lamps behind the LCD, but employ lights mounted around the periphery and an optical system to carry the light and emit rays behind the LCD. Figure 5.4. Because the actual light generating length is limited by the size of the LCD edges, and due to a relatively low optical efficiency, edge lighting techniques do not generally produce very high luminance. However, they have the considerable advantage of very shallow depth because of elimination of lamps behind the LCD. This makes the method applicable to products such as lap-top computers, where a thin profile is of great importance, particularly as power consumption is low. Several techniques are used.

1. Light Pipe: A sheet of plastic is placed behind the LCD and fluorescent lamps are placed along one or more edges of the sheet. Light enters the sheet and is transmitted across by total internal reflection. Light is emitted only when rays hit a discontinuity in the plastic surface which interrupts the total internal reflection. Discontinuities may be an array of bumps or "dots" on the surface of the plastic sheet which faces the LCD. The spacing of the dots will determine the degree to which total internal reflection is interrupted, and the luminance in that area. Density of the dots therefore can be varied to change the luminance. A high dot density is used at areas remote from the lamp, and a wide spacing of dots is used near to the lamp, to develop luminance uniformity. A diffuser may be needed between the light sheet or pipe and the LCD to hide the dot pattern.

A prismatic form of light pipe has been developed where prisms are formed in the plastic surface to create the emission of light. This method is claimed to produce a substantial increase in the resultant luminance due to higher optical efficiency. Luminances up to 5500 cd/sq m (1600 fL) have been produced. Figure 5.5.

2. Woven Fiber Optics: A fiber mat can be constructed from fiber optic strands which are tightly woven so that the radii of curvature are too large for internal reflection and thus transmission through the walls of the fiber optics occurs. Light is collected remotely by the fibers from a tungsten halogen lamp or light emitting diode, and piped to the fiber mat where they form the area of light emission. Up to 35,000 cd/sq m (10,000

fL) has been claimed when this technique is used with multiple light sources. (Lumitex Inc., 11941 Abbey Rd., Bldg. H, Cleveland, Ohio 44133 216-237-5483)

3. Polymer Dispersed Liquid Crystal: This is a unique form of liquid crystal display, rather than actually a backlighting technique, which uses a layer of liquid crystals in a polymer matrix. The LCD is edge lighted, and light is scattered out of the front of the panel when the liquid crystal and the polymer have different refractive indices. This occurs in areas where the liquid crystals are non-activated. The LCD itself is edgelighted and the light rays travel by internal reflection and diffusion through the LCD. Figure 5.6.

Light Curtain

Various developments fall into the category of "light curtains." These are true backlighting systems where parallel fluorescent tubes are used, and a screen of spatially variable transmittance is placed between the actual backlight and the LCD. A reduced transmittance occurs in areas immediately in front of the lamps to lower the luminance in those areas to create high uniformity. A disadvantage is that these techniques are absorptive to some extent and therefore efficiency is reduced.

1. Absorptive Variable Transmission Screen: The actual transmittance is varied, with bands of low transmittance in front of each of the fluorescent lamps. (Figure 5.7)

2. Reflective Variable Transmission Screen: The screen consists of clear plastic but a pattern of reflective dots are placed on the plastic, with their reflective surface facing the lamps. The dot density is greatest in areas close to the lamps. The resultant luminance is reduced in areas near the lamps, and by reflecting the unwanted rays back towards the lamps, some of these rays strike the lamps and other surfaces to be usefully re-reflected, giving an increased efficiency over the purely absorptive screen. (Figure 5.8)

Reflector Systems

The development of narrow diameter straight fluorescent lamps has led to the capability for providing a thin backlighting system based on parallel tubes. Subtractive optical systems have been discussed above which reduced excess luminance to remove stripes on the LCD. Work now is progressing in the development of reflectors which capture light from the areas of the tubes not facing the LCD ie from the sides and rear of the tubes, and redirect that light to the low luminance areas on the LCD between the fluorescent lamps. Designs have been produced which reduce the striation effects to a minimum, with complete removal of the stripes by use of a thin diffuser between the backlight and the LCD. (Lighting Sciences Inc., 7830 E. Evans Road, Scottsdale AZ 85260 602-991-9260)

The performance of reflector techniques is highly dependent on the exact profile of the reflector employed. Minor changes in profile can eliminate or might actually worsen the striping. In particular, attention must be given to ensuring that the LCD is free of

stripes from all viewing angles of interest. Reflector design is achieved by the use of ray tracing software which enables the designer to analyze luminance level and uniformity for varying angles of view, and to perfect the design for the particular geometry of the LCD and lamp system.

## 6. Light Control Materials

Between the backlight and the LCD system, it is usual to place a material which creates diffusion of the light. The purpose of this is generally to produce a smooth lighted pattern from the backlight, but other useful purposes may be provided if the material has optical properties which enhance the backlight's performance.

Where normal diffusion is desired, the thickness and density of the diffuser will effect the degree to which diffusion is obtained and the transmittance of the diffuser. Table 6.1 provides the relationship between transmittance and thickness for a range of diffuse sheets.

As previously described, diffusion in a Lambertian form will give a distribution of light intensity in proportion to the cosine of the angle of view, and thus constant luminance. Usually, however, the angles of view, both vertical and horizontal, are limited to substantially less than ± 90 degrees. By concentrating light in a generally forward direction (perpendicular to the LCD), the intensity and luminances close to the zero degree viewing angle can be substantially increased although the width of the effective viewing angle is decreased. This may be achieved by the use of prismatic lenses or holographic materials used instead of the diffuser. Such materials may exhibit a very substantial gain over the perfect diffuser, although this is at the expense of a reduced range of viewing angles.

Films are produced for brightness enhancement and for diffusion by 3 M Co., 3 M Center, St. Paul MN 55144.

New materials for controlled diffusion are the result of holographic processes. Such materials allow the degree and pattern of diffusion to be developed in a specified manner rather than the random scattering of light produced by conventional diffusers. Table 6.2 provides information on companies producing such materials.

In developing backlighting systems, experimentation with different diffuser types normally is required, as each form of backlight design has its own characteristics regarding viewing angle, luminance uniformity and luminance level. Generally it is desired to develop a uniformity of luminance which just meets specifications, doing so with the least diffusion necessary so as to maximize the optical efficiency of the system. If the field of view is restricted, further luminance enhancement may be achieved by optically removing light at unwanted angles and placing it in the needed direction.

## 7. Design Techniques

Design of illumination systems has traditionally been carried out using ray trace methods. The directionality of light rays can readily be determined using well–known laws of optics for both reflective and refractive media. In order to design a complex light distribution system for an LCD backlight, which may involve numerous lamps and optical elements, traditional ray tracing can be extremely time–consuming and limiting in the number of design iterations which can be attempted. Fortunately, personal computer software has become available to perform illumination system design. The CAD–LITE 3D software allows extremely complex designs to be analyzed by tracing many millions of rays through any given optical system and providing a pre–determination of the resultant luminance level and pattern.

This software is currently in use at the author's facility under a DARPA contract for the investigation and development of new and improved backlighting systems for LCD's. With requirements for increasing efficiency and performance in LCD backlighting systems, it is apparent that advanced software techniques will be essential for design of systems for the future.

## Table 2.1

Example of LCD Backlight Specifications

A. Small Display

| | |
|---|---|
| Active area : | Square, approximately 4.5 ins diagonal |
| Average Luminance : | 6000 cd/sq in required<br>9000 cd/sq in desired |
| Luminance Uniformity : | ± 15 % |
| Angle of View : | ± 60 degrees horizontal<br>± 15 degrees, −40 degrees vertical |
| Dimming range : | 1000:1 |
| Lamp life : | 10,000 hours |

B. Large Display

| | |
|---|---|
| Active area : | 11 x 7 inches |
| Average Luminance : | 15,000 cd/sq in |
| Luminance Uniformity : | ± 15% |
| Dimming range : | 100:1 |
| Lamp life : | 10,000 hours |

**Table 3.1**

LCD Fluorescent Lamp Manufacturers / Suppliers

Partial Listing

Light Sources Inc.
PO Box 3010
70 Cascade Blvd.
Milford CT 06460-0810
203-877-7877

Voltarc Tubes Inc.
PO Box 688
176 Linwood Ave.
Fairfield CT 06430-0688
203-255-2633

JKL Components Corp.
13343 Paxton Street
Pacoima CA 91331
800-421-7244 / 818-896-0019

Harison

I I Stanley
Los Angeles Sales Office
2660 Barranca Parkway
Irvine CA 92714
714-222-0777
714-222-0777

Osram Sylvania
100 Endicott Street
Danvers, MA 01923
508-777-1900

LCD Lighting Inc.
PO Box 3070
11 Cascade Blvd.
Milford CT 06460-0870
203-876-1520

**Table 4.1**

| Order reference | | HTI 250 W/SE | HTI 400 W/SE | HTI 400 W/DE |
|---|---|---|---|---|
| Lamp power | W | 270 | 400 | 400 |
| Lamp voltage | V | approx. 45 | approx. 55 | approx. 55 |
| Lamp current | A | 6 | 7.3 | 7.3 |
| Luminous flux | lm | 20,000 | 30,000 | 30,000 |
| Luminous intensity | cd | 2,500 | 3,500 | 3,500 |
| Average luminance | cd/cm² | 40,000 | 30,000 | 30,000 |
| Luminous area (wxh) | mm | 0.75 x 2.35 | 1.0 x 3.5 | 1.0 x 3.5 |
| Colour temperature | K | 4,600 | 4,600 | 4,600 |
| Average service life | h | 250 | 250 | 250 |
| Burning position | | h45 | h45 | h45 |
| Base | | special | special | SPc9.5–4 |

## Table 4.2

High Intensity Discharge Lamp Manufacturers

Partial Listing

General Electric Co.
Nela Park
Cleveland OH 44112
216-266-2614

Osram Sylvania
100 Endicott Street
Danvers MA 01923
508-777-1900

Voltarc Tubes Inc.
PO Box 688
176 Linwood Ave.
Fairfield CT 06430-0688
203-255-2633

Phillips Lighting
200 Franklin Square Drive
PO Box 6800
Somerset NJ 08875-6800

Venture Lighting
32000 Aurora Rd.
Solon OH 44139
800-437-0111

Ushio Inc.
2-6-1 Ohtemachi
Chiyodaku
Tokyo Japan

**Table 5.1**

Flat Fluorescent Lamp Manufacturers

Partial Listing

Flat Candle Co.
4165 N. Sinton
Colorado Springs CO 80907
719-260-8088

Thomas Electronics Inc.
100 Riverview Drive
Wayne NJ 07470
201-696-5200

Sanyo Electric Co. Ltd
Moriguchi
Osaka 570
Japan

## Table 6.1

Characteristics of Rohm and Haas Plexiglas
White Translucent Sheet

| Sheet | .060" (1.5mm) | .080" (2.0mm) | .098" (2.5mm) | .118" (3.0mm) | .177" (4.5mm) | .236" (6.0mm) | .354" (9.0mm) | .472" (12.0mm) |
|---|---|---|---|---|---|---|---|---|
| W2067 White | 83% | 78% | 74% | 71% | 61% | 52% | NA | NA |
| W2447 White | 68 | 60 | 55 | 50 | 42 | 35 | 27 | 19 |
| W7138 White | 56 | 49 | 44 | 41 | 33 | 26 | NA | NA |
| W7328 White | 46 | 40 | 35 | 31 | 23 | 17 | NA | NA |
| W7420 White | 37 | 30 | 26 | 22 | 15 | 11 | NA | NA |
| W7508 White | 19 | NA | NA | 9 | 6 | 4 | NA | NA |
| MC3015 White | NA | NA | NA | 3 | NA | NA | NA | NA |

**Table 6.2**

Holographic Material Manufacturers

Physical Optics Corperation
20600 Gramercy Place
Torrance CA 90501
213-320-3088

Kaiser Optical Systems Inc.
371 Parkland Plaza
PO Box 983
Ann Arbor MI 48106
313-665-8083

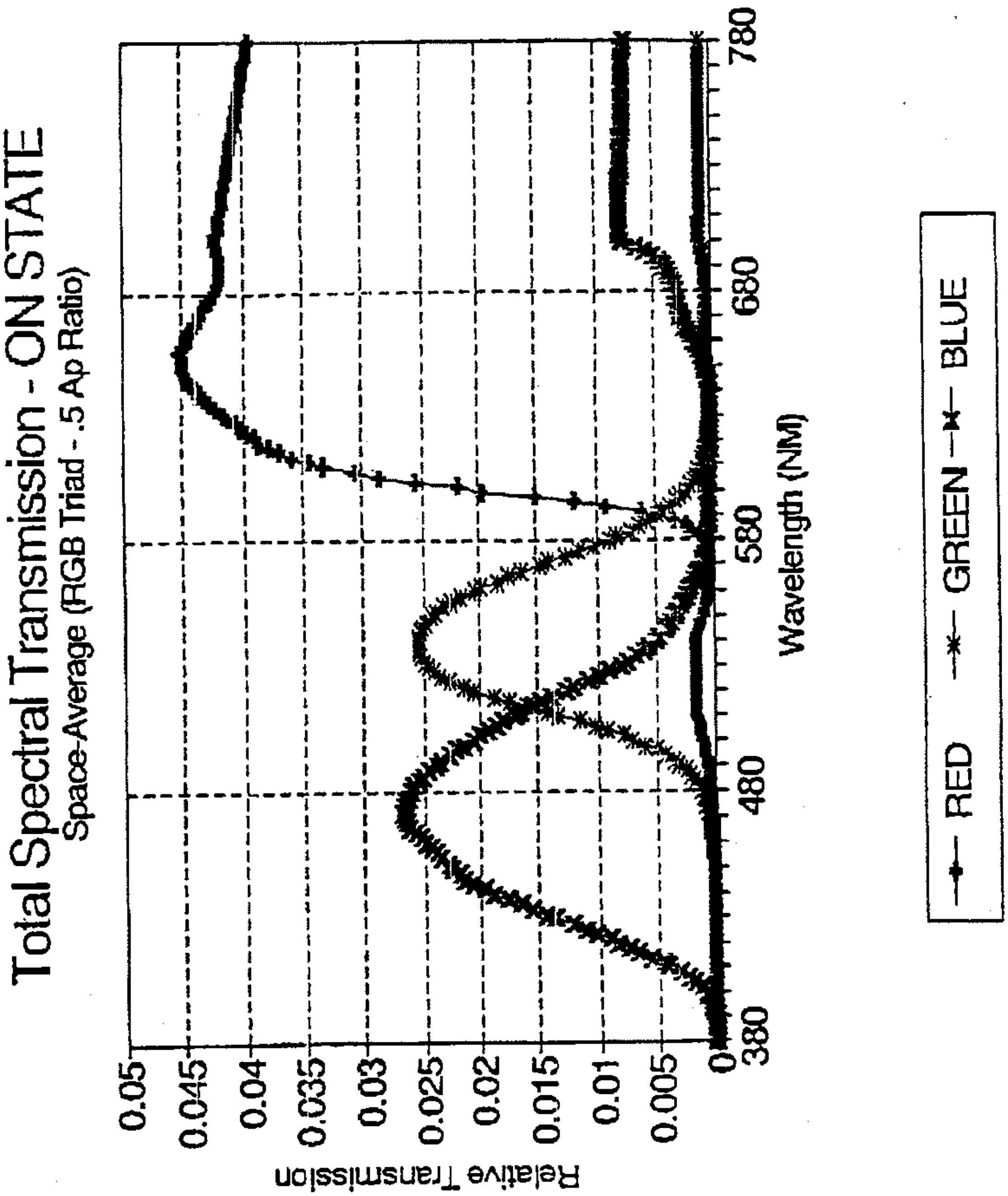
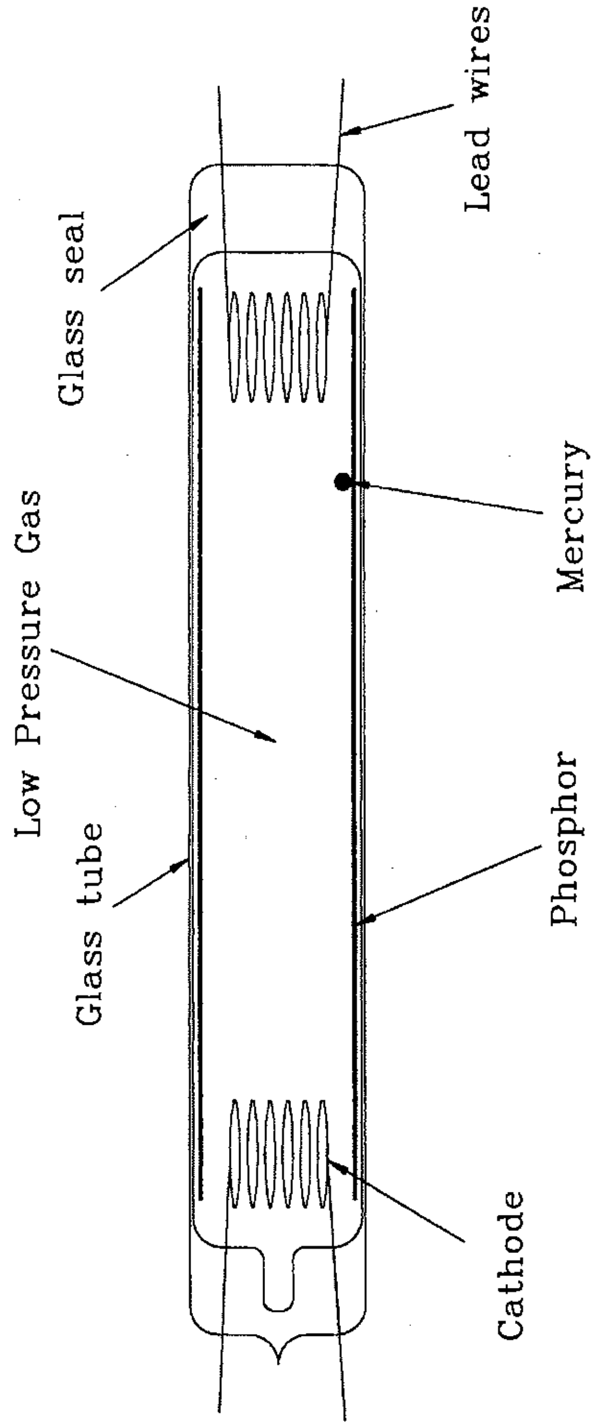



Figure courtesy of Dr. Lou Silverstein
VCD Sciences, Scottsdale, Arizona

Figure 1.1




Longitudinal Section of Fluorescent Lamp
Fig. 3.1

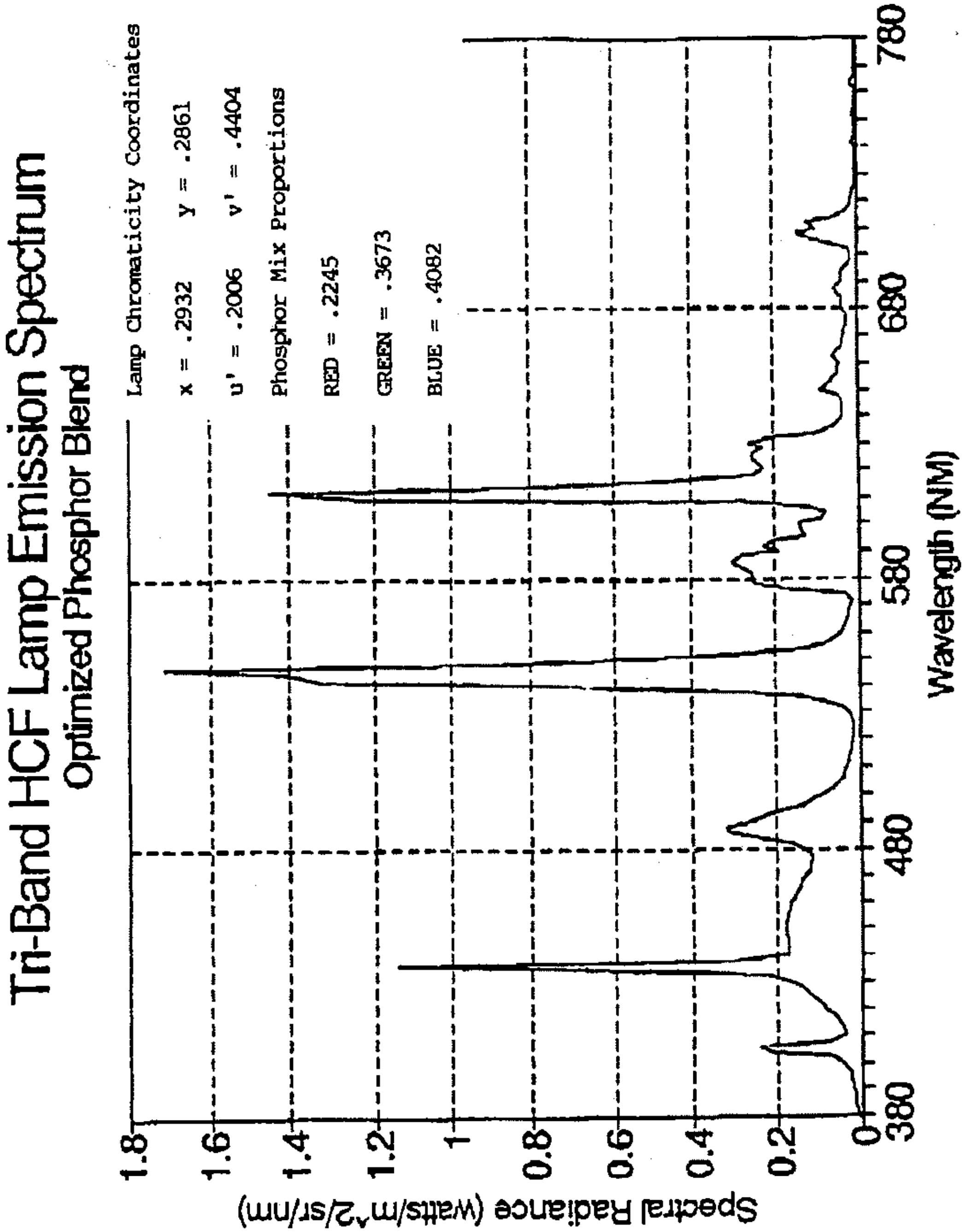
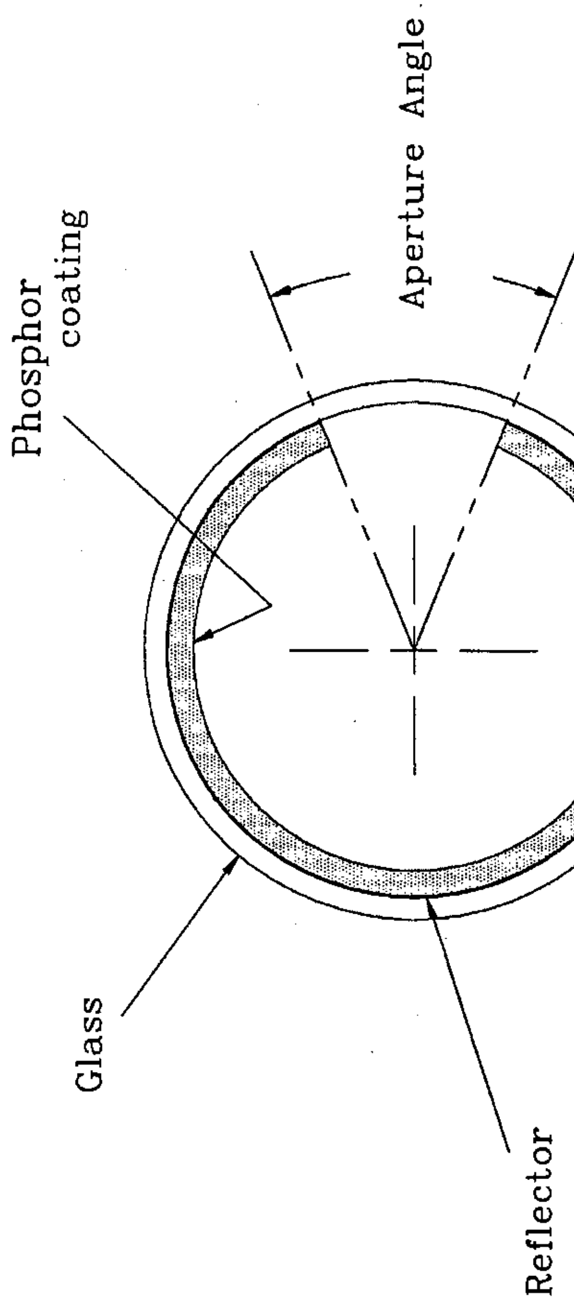
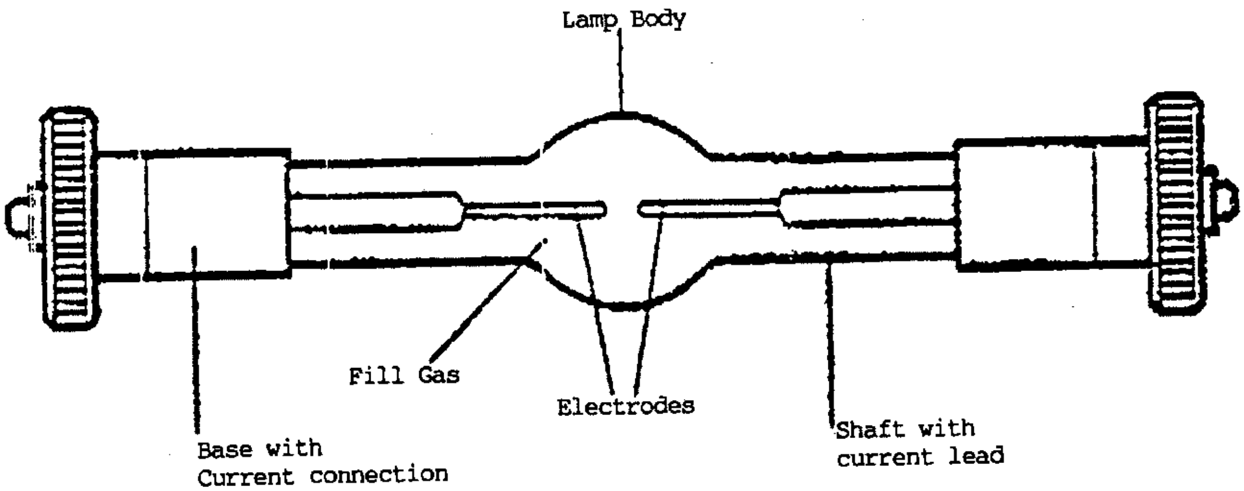



Figure courtesy of Dr. Lou Silverstein,
VCD Sciences, Scottsdale Arizona

Figure 3.2

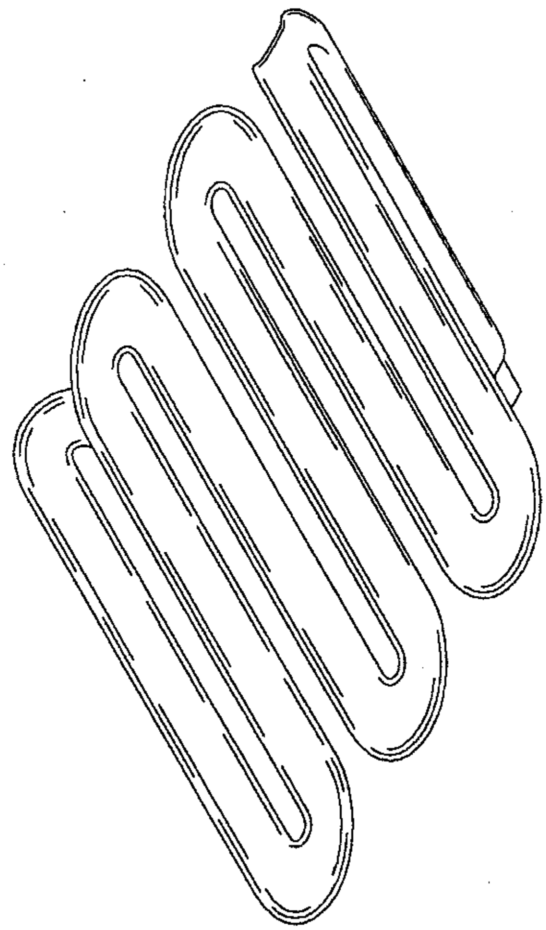



Aperture Fluorescent Lamp
Fig. 3.3

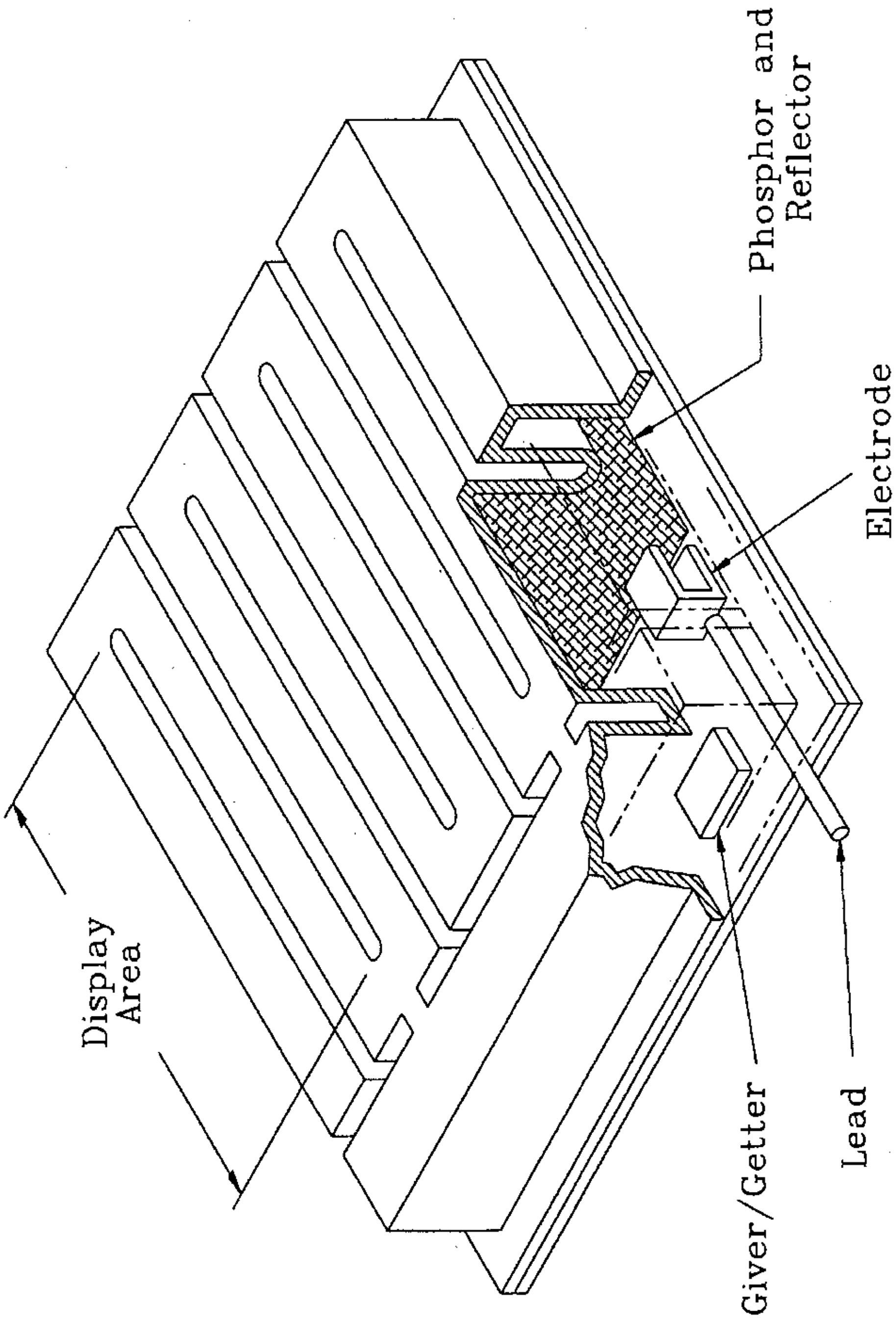

Lamp Body
Fill Gas
Electrodes
Shaft with
current lead
Base with
Current connection

Figure

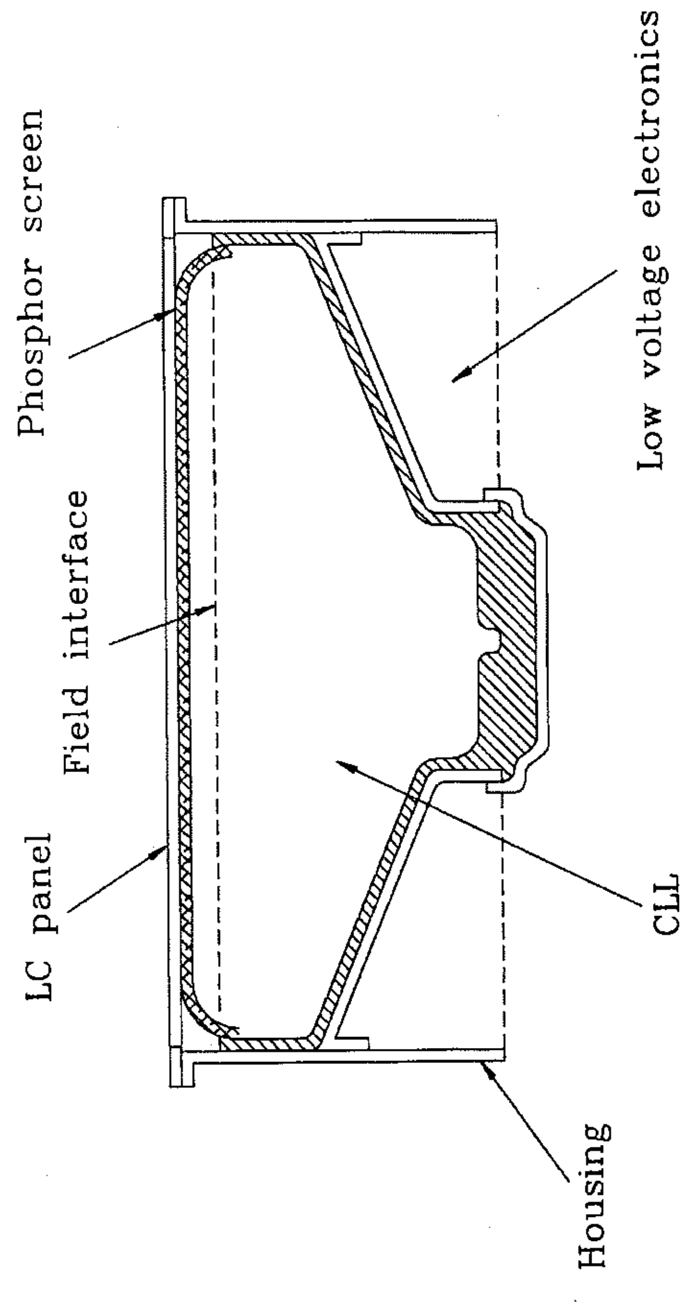
4.1



Serpentine Fluorescent Lamp
Fig. 5.1




Flat Fluorescent backlight
Fig. 5.2




Cathodoluminescent Lamp

Fig. 5.3

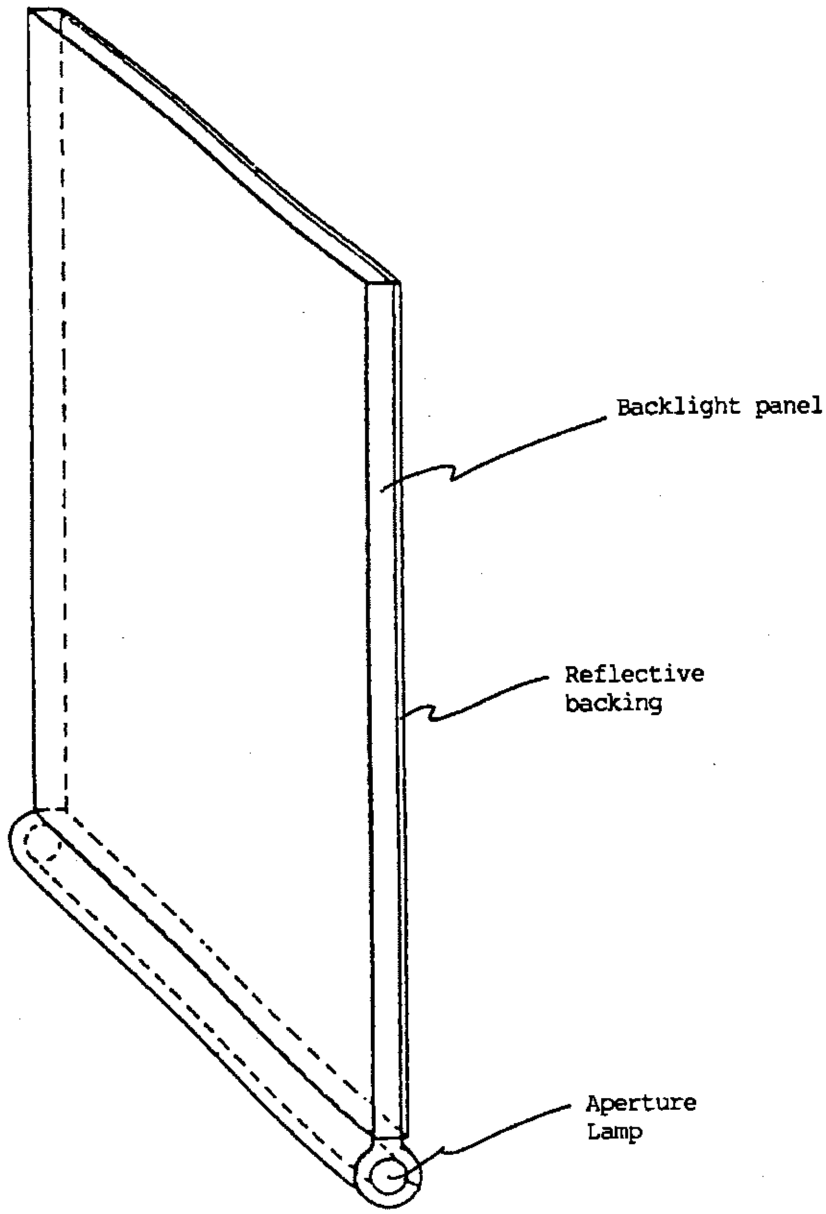
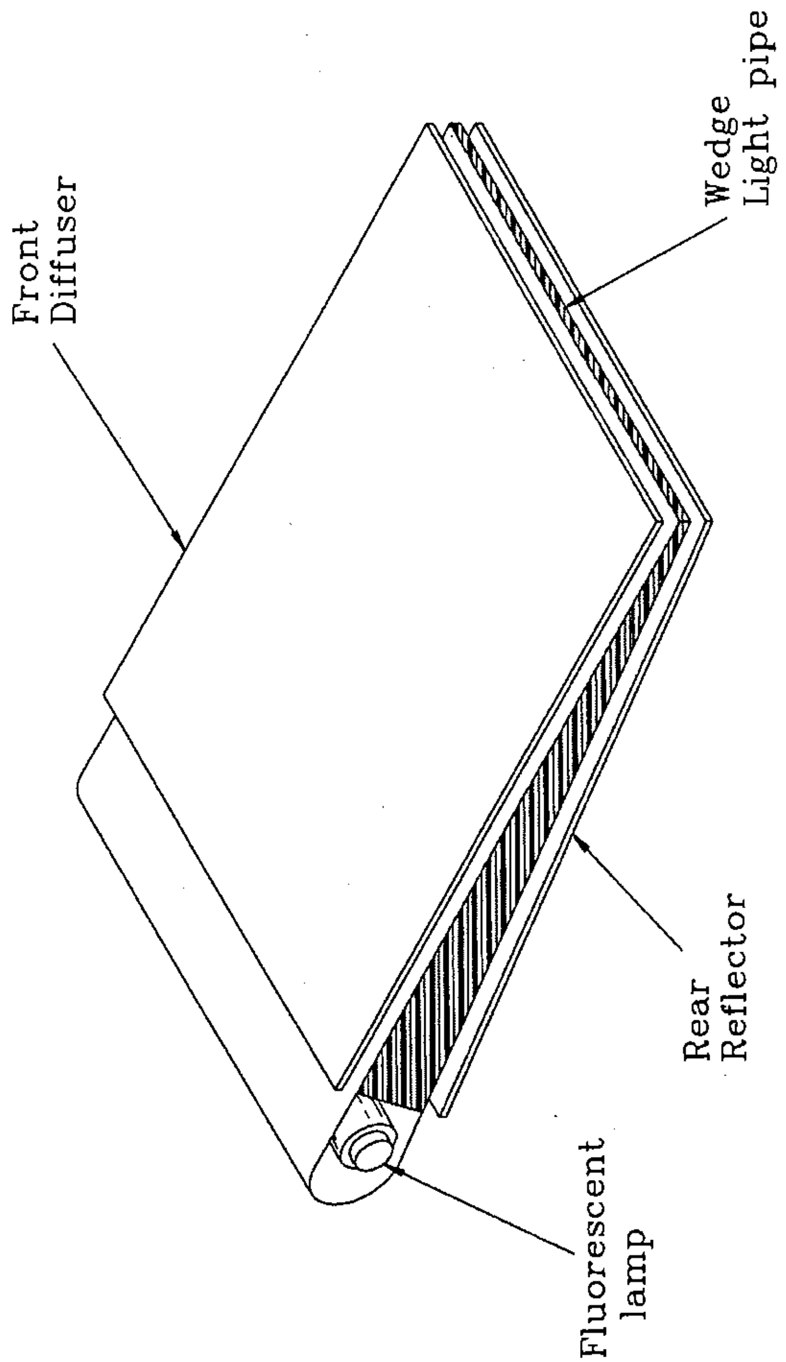



Figure 5.4




Wedgelight backlight
Fig. 5.5

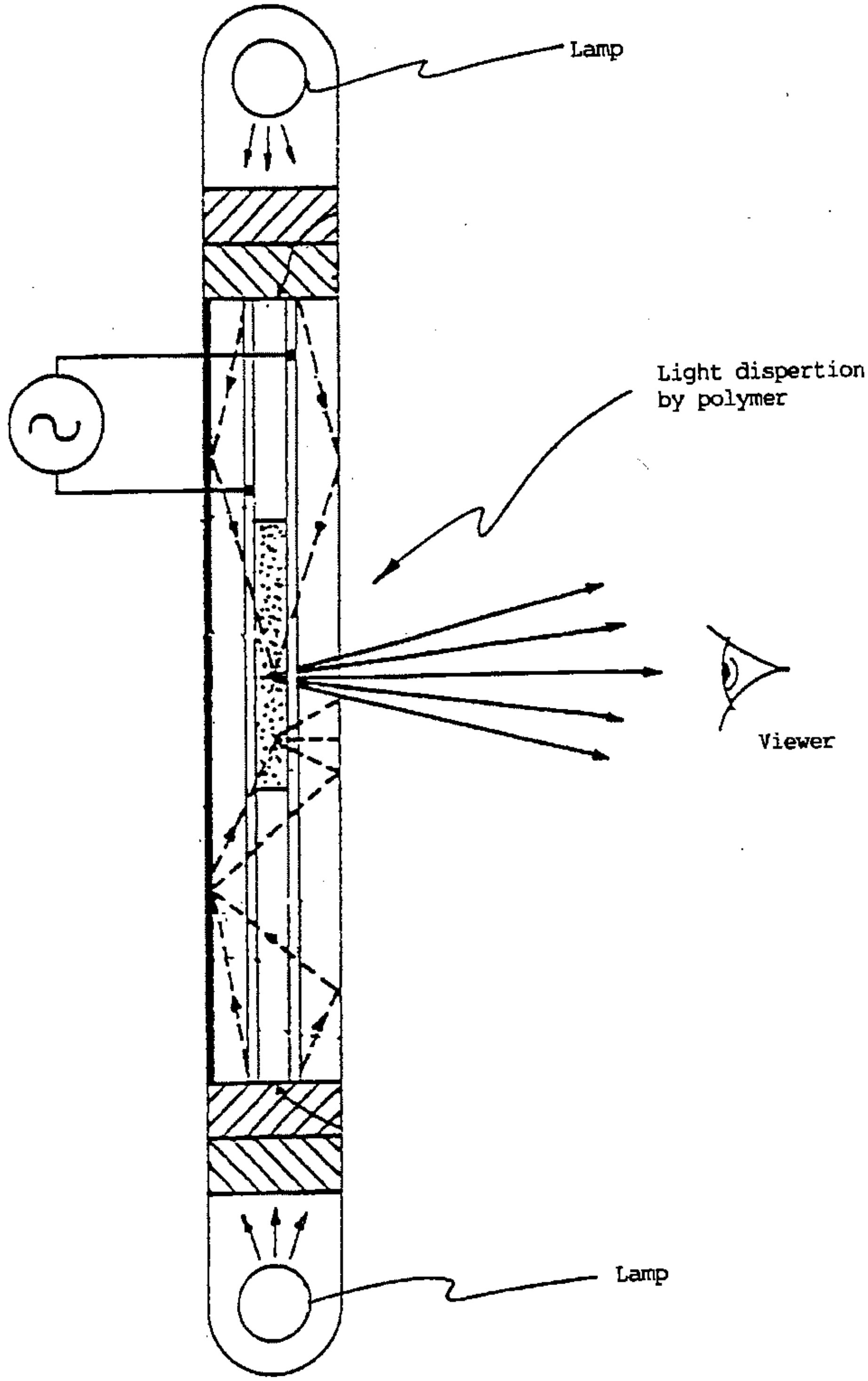
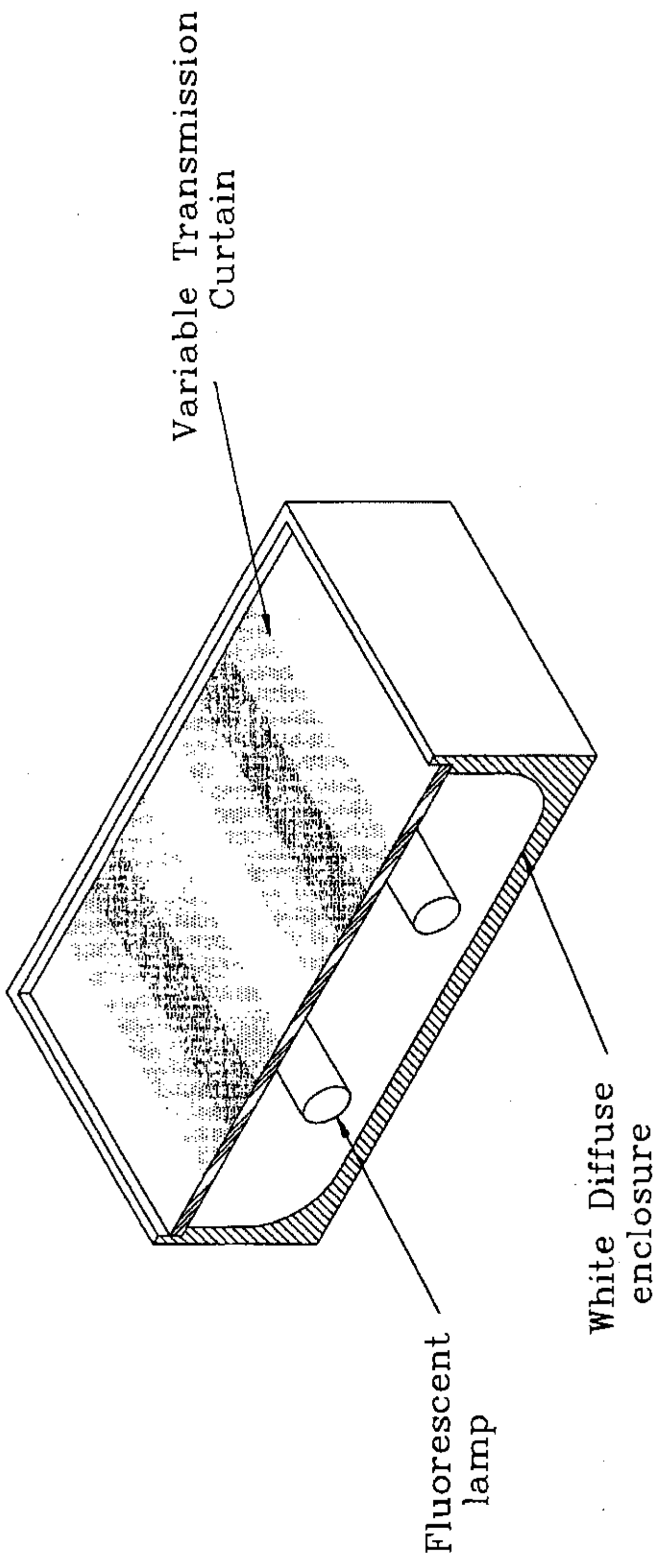



Figure 5.6




Light curtain backlight
Fig. 5.7

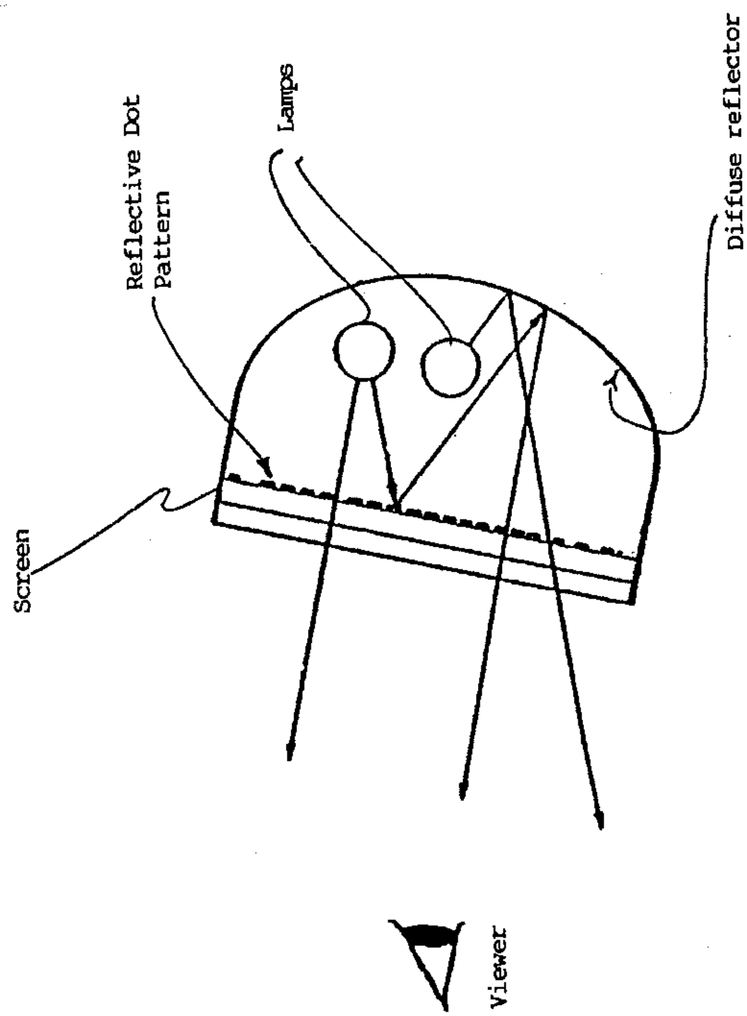

Reflective Dot
Pattern
Lamps
Diffuse reflector
Screen
Viewer

Figure 5.8

Bibliography for LCD Backlighting

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Hataway, K. , Hawthorne, J. , Fleicher, A. (1991). New Backlighting Technologies for LCD's. Society for Information Display 1991 Digest, 751–754.

Hinotani, K. , Kishimoto, S. , & Terada, K. (1988). Flat fluorescent lamp for LCD backlight. 1988 International Display Research Conference (Conference Record 52–55).

Jacobson, B.A., Winston, R., Gleckman, P.L. (1992). Flat-panel Fluorescent-Lamp Backlights with Reduced Illumination Angle: Backlighting Optics at the Thermodynamic Limit. Society for Information Display, SID 92 Digest.

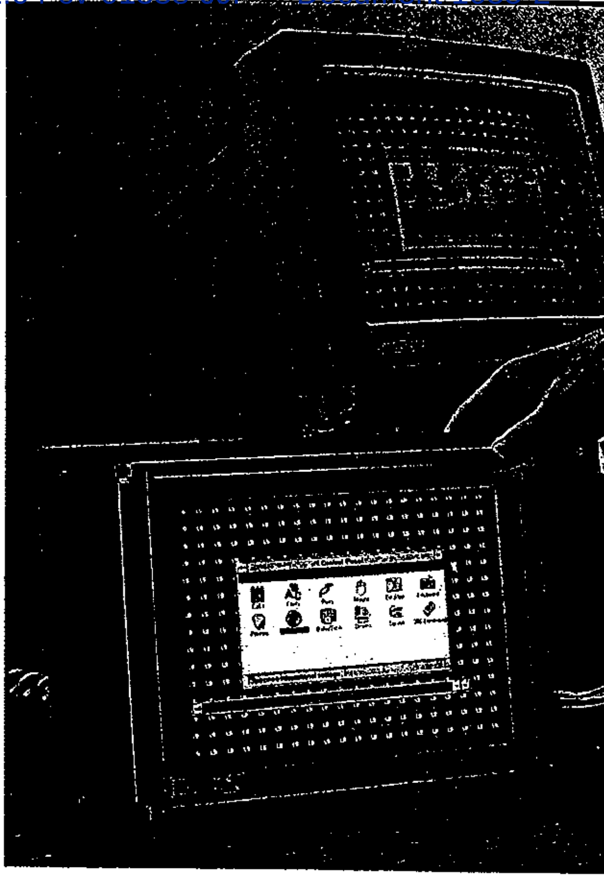
Mercer, B. , Schoke, J. (1989). Fluorescent backlights for LCD's. Information Display, 11(5), 8–13.

Whitehead, L., deVaal, J. (1992) Light Distribution Methods for Backlighting LCD's. Society for Information Display, SID 92 Digest.

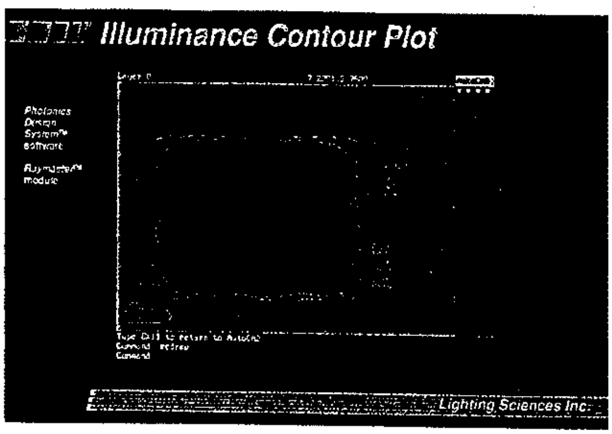
# EXHIBIT 11

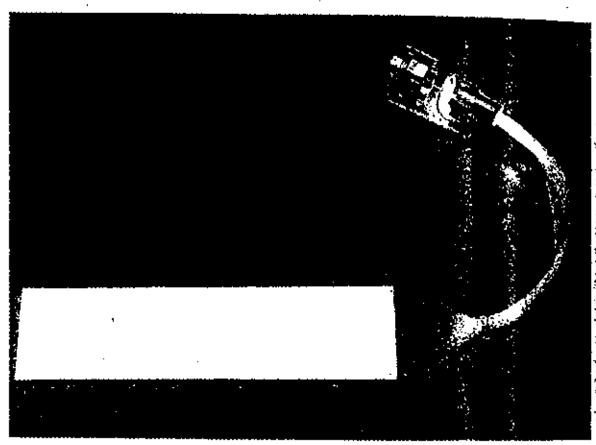
To

DECLARATION OF ALEXANDER E. GASSER
IN SUPPORT OF
DEFENDANTS OPTREX'S, FUJIFILM'S, SAMSUNG SDI'S AND
CITIZEN'S RESPONSIVE MEMORANDUM OF LAW
IN SUPPORT OF THEIR PROPOSED CLAIM CONSTRUCTION



*Experts believe these high-luminance, 1-inch-deep monitors will virtually replace the CRT*



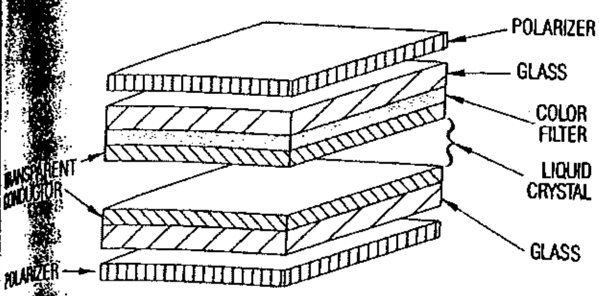



# LCDs: The Backlighting Challenge

At top, the conventional CRT monitor and active matrix LCD panel are both driven by the same computer with identical displays. The AMLCD is backlighted with parallel miniature fluorescent lamps and high-performance optics, producing a dramatic difference in luminance and color quality. To help analyze such a system's optical efficiency and flux uniformity, RAYMASTER software can produce illuminance contour plots. An alternate backlighting strategy, woven fiberoptics (at right), also produces an thin, fairly uniform, high-luminance sheet of light.

Ian Lewin

Liquid crystal technology has been widely used for information display for many years in applications such as pocket calculators and lap-top computers. LCDs (liquid crystal displays) are evolving from these familiar simple systems into incredibly complex and powerful devices. With the advent of the active matrix liquid crystal display (AMLCD), a new world of video technology is becoming possible, ranging from full-color, high-speed computer monitors to




An activated crystal will not rotate a light ray's plane of polarization, preventing it from passing through the oppositely oriented front and rear polarizers.

high-definition television. These systems far surpass the traditional passive matrix LCD systems. Many experts believe that AMLCD devices will almost totally displace traditional CRT display systems by the end of the century.

A great advantage of the new LCD systems is that they provide displays with minimum volume—these are truly flat panel video displays—but with the resolution, speed, and color quality associated with traditional CRT devices. Computer monitors of this type have recently become available, and "hang-it-on-the-wall" television is approaching reality.

Further advantages of AMLCDs are their very low power consumption and cool operation, which when coupled with the savings in space, make these the systems of choice in high-technology applications. For example, in the newly unveiled Boeing 777, AMLCD's have replaced traditional avionic systems in this fly-by-computer aircraft.

The active matrix LCD comprises a sandwich with the front and back plates formed from polarizers in opposite orientations. Between the polarizers is a layer comprising individual liquid crystals, each of which forms a display pixel.

Each liquid crystal can rotate the plane of polarization or leave it unaffected, depending on whether the crystal is in its non-activated or activated state. Thus, light rays passing through the rear polarizer will be directly transmitted by a liquid crystal and have their plane of polarization rotated to be transmitted by the front polarizer. However, if activated, the liquid crystal will not rotate the plane of polarization, and the front polarizer will absorb the ray. When lighted from behind, therefore, any pixel in the LCD array may cause passage or blockage of light, depending on its state, creating the video image.

Adjacent to each liquid crystal is a dedicated, high-speed transistor that activates or deactivates the liquid crystal upon a signal from the driver electronics, which in turn are operated by the associated computer. Full-color video capability is possible because the liquid crystals are laid out and operated in groups of three, each having a blue, green, or red filter in front of it. Advancing technology has allowed the commercial production of systems, for example, with 640 by 840 pixels in a roughly 8-by-6-inch display—more than 300,000 pixels.

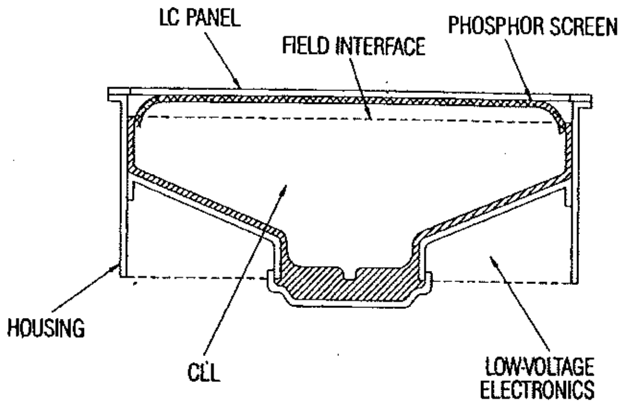
## Lighting requirements

Slow-speed, passive matrix liquid crystal systems such as those found in pocket calculators rely on reflected light to create the image. Passive matrix LCDs used in lap-top computers employ a simple backlight that provides fairly low luminance. AMLCD devices, however, require high-luminance backlighting.

Active matrix systems have very low transmittance, roughly 4 percent for color displays, and therefore a high-luminance source is needed to produce satisfactory luminances after transmission through the display layers. A very high degree of uniformity is nececessary in the backlight so as not to disturb the quality of the video image. What is needed, therefore, is a flat thin sheet of light of very high luminance and near-perfect uniformity. This has been found to be a substantial technical challenge, particularly if the system is to be battery operated and minimum power is essential.

Luminance requirements vary by application. For an aircraft avionics system that must be viewed under high ambient lighting, 800 cd/m$^2$ or more may be desirable. This will require a backlight that produces about 20,000 cd/m$^2$. A typical computer monitor may need one-third to one-half this amount.

In terms of luminance uniformity, the requirements are not entirely straightforward. To create the visual effect of near-perfect uniformity, it is essential to eliminate striations and patches caused by backlight optics or lamp images. Such effects are readily detected by a viewer and are highly objectionable. In our work we have found that an allowable variation not exceeding ±5 percent of average is required for all measured points in close proximity, say within 1 inch of each other.




**The cathodoluminescent lamp is a viable alternative, but its depth and high surface temperature are disadvantages.**

However, an overall uniformity up to ±15 percent of average is acceptable if this is a gradual luminance reduction from the center to the edges and corners of the display.

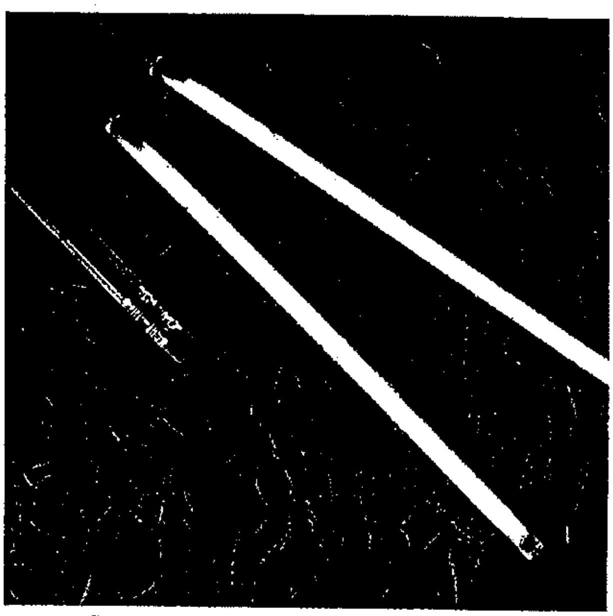
## Lighting techniques

Numerous techniques have been tested to produce the uniform, high-luminance "sheet of light," with varying success. The light source types that may be used are

- electroluminescent panels
- incandescent (quartz halogen) lamps
- metal halide lamps
- cathodoluminescent lamps
- fluorescent lamps in various forms

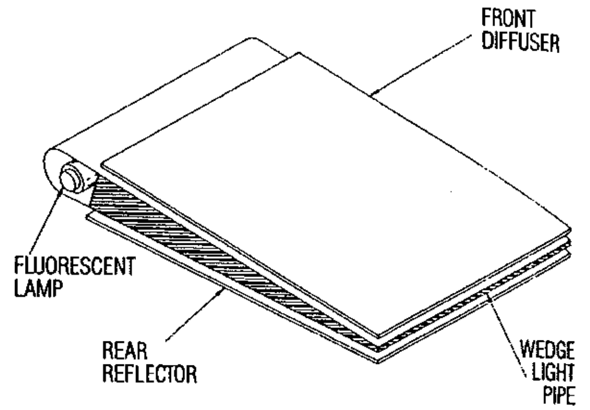
*Electroluminescent*—This light source has been available in flat panels for many years. It has the advantage of very good uniformity, but unfortunately, has low luminance, generally unsuitable for AMLCD applications. Recent developments in this technology are increasing the luminance yield, and useful new forms may be developed in the future.

*Incandescent*—Quartz halogen incandescent lamps seem to be the opposite of what is needed because of their near-point-source characteristics. However, a backlighting system has been produced in which this lamp is used with a fiberoptic cable. An elliptical reflector injects the light into a multistrand cable. The cable is then woven into a fiberoptic mat, just as threads are used to weave a cloth. The sharp bends in the fibers caused by the weave create light leakage over the surface of the mat, producing a fairly uniform, high-luminance area.



**Miniature fluorescent lamps as small as 3 mm in diameter have been produced in varying lengths.**

*Metal halide*—These sources are used mainly in optical systems closely resembling overhead projectors. The transparency typically used with such projectors can be replaced with an LCD, and the LCD image is cast onto a screen. In its advanced form, the LCD is quite small, using a very-high-resolution AMLCD, and is illuminated using a very-high-luminance metal halide lamp, much like a high-powered color slide projector. Metal halide lamps are not typically used in "direct view" flat panel displays.




**Prismatic edge lighting, in which prisms are formed in a wedge-shaped plastic layer, boasts good uniformity but poor efficiency.**

*Cathodoluminescent*—This new form of lamp has been developed specifically for LCD backlighting and is being used in avionics displays. It is strictly a fluorescent lamp comprising a flat front panel of phosphor that is excited by radiation. A rear electron gun, produces a cloud of electrons and the excitation. Near the phosphor surface, a high electric field causes electron acceleration, and thus the electrons bombard the phosphor layer. High luminance has been developed with good uniformity. A disadvantage of this system is depth, as it requires about 3 inches for the overall package. Possible high surface temperature may require forced cooling.

*Fluorescent*—By far the most popular lamp type for AMLCD backlighting is fluorescent, with new varieties being produced for these specific applications. Variations of fluorescent lamp technology are

- edge lighting
- light curtain
- serpentine lamps
- reflector optics

A major requirement of LCD lighting is minimum volume, and miniature fluorescent lamps have been developed both in hot and cold cathode form. Lamps as small as 3 mm in diameter have been produced, in varying lengths. These may be straight

r near-point-
:tem has been
:roptic cable.
:strand cable
.st as threads
:ibers caused
e of the mat
a.
y in optical
:. The trans-
be replaced
:en. In its ad-
. very-high-


dge-shaped

very-high-
wered col-
lly used in

has been
d i. ng
:ent lamp
excited by
electrons
gh electric
:ons bom-
leveloped
n is depth,
: Possible
ng.
r AMLCD
:ing pro-
f fluores-

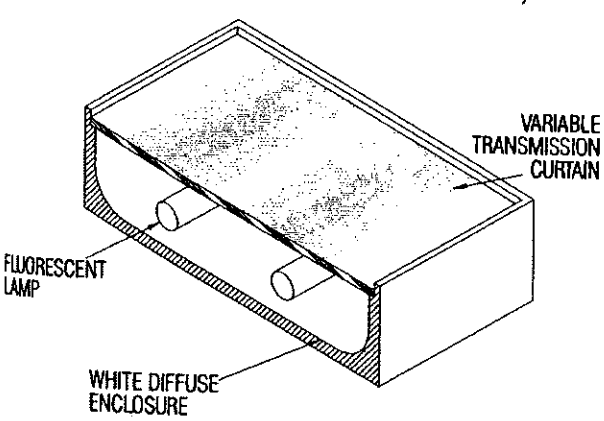
volume,
d both in
diameter
: straight

tubes or a variety of bent configurations. There are several different methods of applying fluorescent lighting technology to LCD backlighting.

*Edge lighting, or light pipe*—As the name suggests, in this application the fluorescent lamps do not lie behind the liquid crystal display, but are positioned along one or more edges of the display. In its simplest form, a sheet of plastic is placed behind the LCD with a fluorescent lamp running adjacent to the edge of the sheet. Typically, a lamp with a small cross section is used. A reflector system may direct light into the side of the plastic sheet, where it is piped across via total internal reflection. Light is emitted only when a ray hits a discontinuity in the surface of the plastic sheet, and designs have been produced with controlled surface irregularities, bumps or dots, to cause light emission. The spacing of the irregularities controls the amount of light emitted, and a high degree of uniformity is possible.

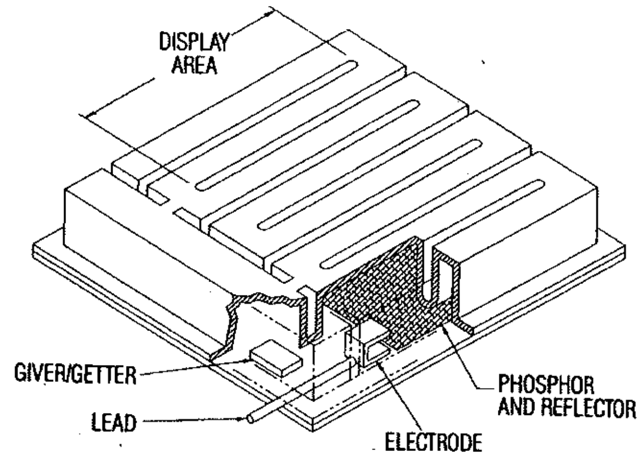
A prismatic form of edge lighting has been developed in which prisms are formed in a wedge-shaped plastic layer to give controlled emission. A white diffuser between the wedge system and the LCD smoothes out local irregularities. Edge lighting systems produce only moderate luminance levels because of the limited lumen output that can be collected from the lamp. Nevertheless, they are suitable in certain applications.

*Light curtain*—When a true backlighting system with multiple parallel fluorescent tubes is used, there is a natural tendency to produce dark and bright stripes, corresponding to the location of each lamp. While these stripes can be reduced by the use of a diffuser between the lamps and the LCD, there is a substantial efficiency penalty and less-than-satisfactory results.




The light curtain partially blocks transmittance directly in front of the lamps. This subtractive method is inefficient by definition.

The "light curtain" has been developed to overcome the striping problem. This device is an optical element, a plastic sheet onto which black dots are deposited. The spacing between dots is small in areas in front of the lamps, while the dots may be eliminated entirely between lamps. This subtractive method removes excess luminance in front of the lamps to produce a uniform appearance, although a white diffuser in front of the light curtain also is necessary. Because of the inefficiency of this system, a modified system is in use where the rear side of the dots, the side facing the lamps, is reflectorized. This in-




**The flat fluorescent lamp comprises two molded-glass elements cemented together to form a single serpentine discharge tube.**

creases efficiency as the unwanted light reflects back into the white lamp housing, some of which then is usefully re-emitted.

*Serpentine lamps*—Two forms of serpentine-shaped lamps are available. In the basic form, it is a single discharge tube that has multiple bends forming multiple parallel legs. While this does not produce a uniform area of light, when used with a suitable reflector and front diffuser, it can be highly effective.

Another form of fluorescent lamp, sometimes called the flat fluorescent lamp, is a serpentine discharge tube formed from front and rear molded-glass elements. These are cemented

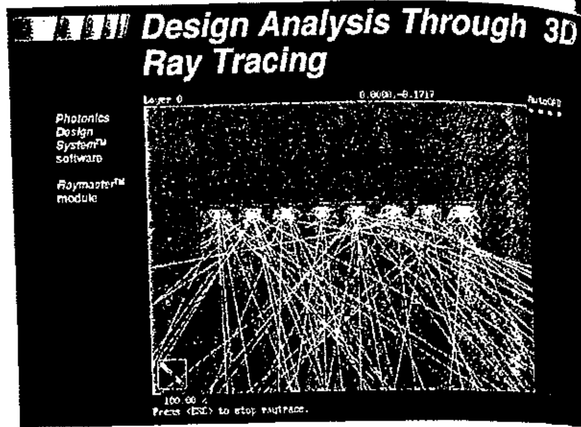
together to form a single discharge tube that approximates a light-emitting flat area.

### *Reflector optics*

Parallel fluorescent tubes behind the display area represent common technology, and this approach suffers from needing a highly diffuse material to even out strong lamp images, creating low efficiency. Recent advances in computer-aided optical design, however, have allowed the development of a high-efficiency reflector system for use with parallel tubes that casts a flat, uniform light on the target plane.

The principle of the new reflector system is that light traveling rearward from the tubes is collected by a complex reflector and is redirected forward to the focal plane. At every point on the focal plane, light is also received directly from the lamps. The precision reflector contour places exactly the amount of reflected luminous flux at every point on the target focal plane as is required to compensate for variations in the direct light, producing, essentially, perfectly uniform total incident light. Thus, the net result is a flat lighted area without perceptible stripes.

Extensive work has been performed using RAYMASTER software under sponsorship of ARPA (US Advanced Research Projects Agency) to develop this design. By ray-tracing analysis




This RAYMASTER screen capture shows a ray trace in progress for a double-cusp reflector for parallel fluorescent tubes.

using a Monte Carlo technique, millions of rays can be traced rapidly, and an optimized form of reflector is produced. The software analyzes optical efficiency based on the lumens falling on the defined focal plane immediately in front of the lamps, and provides flux uniformity information. Incident flux contour plots then can be developed, as well as computer-generated visual renditions of the appearance of the simulated design.

By employing a reflector contour that ensures that all captured light is redirected to its desired point on the focal plane using only a single reflection and by having no rays reflected back into a lamp, a very efficient system is developed. Reflector systems of this nature have been produced that have optical efficiencies exceeding 90 percent. Uniformity is such that the luminance of points on the lighted plane in front of lamps and between lamps varies by as little as ±3.5 percent. Luminances in excess of 30,000 cd/m$^2$ have been achieved, rendering them suitable for the most demanding applications. The difference in luminance and color quality between a conventional CRT monitor and an active matrix LCD is dramatic.

The new world of the active matrix LCD is now here. Fierce competition exists between Japan and the US in this area, and a multi-billion dollar industry is involved. The next few years promise to be exciting as high-technology commercial, military, and consumer products become available using these startling display devices. Behind it all (excuse the expression) is the backlight, for no device of this type can function without the proper lighting system. It appears we are moving onward into the next century with the skills of the lighting engineer becoming more critical than ever before.

*The author:* Ian Lewin president of Lighting Sciences Inc. of Scottsdale, AZ, an independent company that provides research and development, design, and testing services for illumination systems. The company is a contractor to ARPA for LCD backlighting system research. Mr Lewin holds the PhD in illuminating engineering from University of Newcastle, England. He is a past director and a Fellow of the IESNA. A member and past-chairman of several IESNA committees, he holds the Society's Distinguished Service Award. He has published more than 70 papers and holds 17 patents.

# EXHIBIT 12

**To**

**DECLARATION OF ALEXANDER E. GASSER**
**IN SUPPORT OF**
**DEFENDANTS OPTREX'S, FUJIFILM'S, SAMSUNG SDI'S AND CITIZEN'S RESPONSIVE MEMORANDUM OF LAW IN SUPPORT OF THEIR PROPOSED CLAIM CONSTRUCTION**

# 1994

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# 19.3: The Development of a High-Performance LCD Backlighting System

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**Lighting Sciences, Inc., Scottsdale, AZ**

Abstract: A backlighting system with substantially improved optical efficiency has been developed. Design work was conducted using computer software specifically developed for such purposes. Using parallel fluorescent lamps and a uniquely contoured silver reflector, luminance levels of approximately 9000 footlamberts have been achieved, with near-perfect uniformity. Results from prototype systems are provided.

## Introduction

A project has recently been conducted partially under ARPA funding for the investigation into characteristics of LCD backlights and methods of possible improvement.

Numerous lighting techniques exist for backlighting, and various methods have advantages and disadvantages depending upon the specific application. Ref. 1 and Ref. 2. Development of an improved backlighting system has concentrated on active matrix color displays used under conditions where high luminance is necessary. The aim of the project was the selection of a basic backlighting system and then to optimize the system optically to provide high average luminance with good uniformity and low power use. Extensive computer modeling was used as a tool in conducting the optimization.

## Basic Design Approach

Efforts have been concentrated on the development and refinement of a fluorescent lamp system. While other light sources have efficacies (lumens per watt) equal or greater than fluorescent, for example metal halide or sodium high intensity discharge sources, they are generally unsuitable for reasons of size, color or the impracticality of producing low wattage versions. Miniature fluorescent lamps have been developed specifically for backlighting applications and have the advantages of high lumen output per watt, high luminance, long life, and spectral distributions which can be tailored to the transmittance characteristics of an LCD. Hot and cold cathode versions offer a trade-off between light output, life and ruggedness. Hot cathode sources were selected in order to optimize luminance, although the optical designs which evolved are equally applicable to cold cathode lamps.

Fluorescent backlighting can be achieved either by edge lighting where the light is piped across the area behind the LCD, or by using parallel tubes in a bank behind the display. Edge lighting with refined optics can produce uniform backlighting, but it is limited to low or moderate luminances and generally low optical efficiency.

Parallel individual fluorescent lamps certainly do not represent a new concept for LCD backlighting, but previous systems suffer from either poor uniformity because of bright and dark stripes, or low optical efficiency, or both of these problems. Previous methods have been devised to reduce the excess luminance in front of the lamps by basically subtractive means, at the considerable expense of further reducing the system optical efficiency.

Our efforts have concentrated upon developing a very high optical efficiency while producing almost imperceptible luminance gradients, yielding near-perfect uniformity with very high luminance. While the approach has been developed for parallel fluorescent tubes, hot or cold cathode, it is equally applicable to serpentine shaped lamps.

## System Components

As illustrated by figure 1, the LCD backlight system consists of a series of components:

1. Parallel straight fluorescent lamps, 7.2 mm diameter. Lamp length is determined by the display size. Lamp spacing is a variable and is dependent upon the required luminance level.

2. A double-cusp form of reflector system, discussed in more detail below. This is formed from a base substrate onto which a silver film is deposited.

3. A thin flat diffuser in a defined reference or target plane of the reflector, and a Brightness Enhancement Film (BEF) as manufactured by 3M Company.

4. The LCD.

All optical components apart from the LCD are of high inherent optical efficiency, and subtractive means of removing hot spots or luminance striations are unnecessary because of the form of reflector. The least efficient optical component (apart from the LCD itself) is the diffuser. Diffuser transmittance, however, is strongly influenced by the required degree of diffusion. A relatively non-uniform luminance distribution can be smoothed out by a fairly thick or highly diffusing material, but at considerable cost in absorbed light. Conversely, if a lamp and reflector system can be designed which creates a highly uniform luminance distribution in the target plane, then a very thin, lightly diffusing material can create the appearance of near-perfect uniformity while itself having high transmittance. Thus the key to high optical efficiency is in the use of a contoured reflector which forms a uniform light pattern on the target plane diffuser, eliminating the need for a low transmittance, highly diffusing diffuser.

The reflector system which creates the uniform luminance must itself operate with high efficiency, minimizing losses due to multiple reflections of a given light ray, and eliminating as far as possible the redirection of light back into a fluorescent lamp.

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### Reflector Design

A parallel tube lighting system without a reflector will cause striations of high luminance on the reference plane, (normally the plane of the diffuser), directly in front of each lamp. Luminance will reduce sharply at points on the plane between the lamps. Meanwhile, light generated by the tubes which does not directly strike the focal plane, that is the slightly over 180 degree angular range behind the lamps, is wasted. The optimum reflector design will capture 100% of the otherwise wasted light and redirect it onto the reference plane at points where the luminance is low, i.e. between the tubes. In the ideal situation, the redirected light from the reflector will be spread on the target plane in such a manner as to compensate exactly for the non-uniformity of the light received on the plane directly from the lamps. The net result of this ideal situation will be a total absence of striations because the additive effect of the direct and reflected light will give an equal amount of light at every point on the reference plane.

Redirecting the light captured by the reflector with 100% efficiency is not possible. However, by the use of a silver film of roughly 95% reflectance, and by employing a cusp or Vee behind the lamp to minimize light redirected into the tube, very high efficiency can be achieved providing the proper reflector contour is used. In our reflector development work, an overall optical efficiency, defined as the total lumens received on the reference plane expressed as a percentage of the total lamp lumens generated, of over 90% has been reached.

In order to produce the desired uniformity, the illuminance (lumens per unit area) incident upon the reference plane must be approximately equal at all points, whether directly in front of a tube or at any point between tubes. Moreover, a uniform appearance of the reference plane must be achieved for all directions of view. As the observer's eyes may be located anywhere in a defined visual angular range, the directionality of the incident light onto the reference plane must be considered; uniformity must be achieved for all eye positions. This is a highly complex optical design problem.

### Raymaster™ Photonics Design System™

Use of Raymaster™ software, a program for the design and analysis of illumination optics, allowed computerized modeling of the system. The software uses a ray tracing procedure based on the Monte Carlo principle, and includes the capability of modeling a wide range of materials and lamp types. Material reflectance characteristics are included in a file generated by an in-house gonio-reflectometer. Output metrics include luminance tabulations and contours, system efficiency, and the generation of simulated photographs of the backlight performance. Raymaster software operates within the AutoCAD™ program and thus incorporates standard features of this widely used software. A screen capture illustrating an in-process ray trace is shown in figure 2.

It is known that widespread even illumination of a flat plane from parallel fluorescent lamps can be achieved using a double-Vee reflector, (U.S. patent no. 4,388,675). This provided the starting point for the design effort.

Space does not permit a description of the numerous design steps. However, by a process of design iterations and feedback from the Raymaster™ software, a reflector profile was developed which came extremely close to meeting the design goal of perfect uniformity of reference plane illuminance.

Achieving this level of uniformity proved difficult and required many design iterations, made possible by the accurate modeling capabilities of the software employed. The final profile consists of a double Vee with a precisely designed curved contour between the cusps.

The exact curvature required and the results achieved are dependent upon several factors, mainly the luminance level required (which dictates the tube spacing) and the spatial considerations, primarily the light source to reference plane distance.

### Diffuser Material

As mentioned, a minimum amount of diffusion is required if the illuminance on the reference plane is highly uniform. We are able to use a thin acrylic material and provide a uniformity which is visually near perfect. Actual measured values of luminance on the front of the diffuser at points between lamps and in front of a lamp are within a few percent of the average of those points. This variation is imperceptible to the human eye.

A further substantial increase in luminance was achieved by the use of 3M Brightness Enhancement Film between the diffuser and the LCD. This has the effect of concentrating the emitted light rays into a narrower angular range, yet still covering the desired visual range, and thus producing a worthwhile luminance increase.

### Prototype Backlights

As part of the development, prototype backlights were produced to check the accuracy of the computer predictions. These were manufactured from machined aluminum which was then silvered. Measurements of luminance were made using a Photo Research Spectra Spotmeter.

A close correlation was found between measured and predicted results. The software was found to be reliable and usable as an accurate tool for this form of optical design.

Prototypes were made of two sizes of backlight, to be used for the larger display (6 inches x 8 inches) and smaller display (3.2 inches x 3.3 inches). The larger size corresponds to a widely available color AMLCD used in personal computers, while the smaller size is that of a typical aircraft avionics HSI (horizontal slope indicator) display. Lamp spacings are 0.75 inches and 0.815 inches for the larger and smaller displays respectively.

### Results Achieved

Measurements were made on both the larger and smaller prototype displays, for several types of diffuser and for a

diffuser plus Brightness Enhancement Film. As anticipated, heavy diffusion is unnecessary as near-perfect uniformity was achieved with very light diffusers. (Rohm and Haas Plexiglass 2447 and Plex L 20, thickness .060 inches.)

Average luminances and luminance uniformities were calculated. Uniformity can be defined in numerous ways. In general, a gradual reduction in luminance towards the edges and corners of a display is not objectionable. Striping caused by luminance striations due to the parallel lamps, however, is much more disturbing to the viewer. A meaningful value of uniformity therefore is the luminance variation across a line running perpendicular to the tubes, which will quantify the striping effect.

Point by point luminance measurements were taken across the prototype displays, along a centerline perpendicular to the lamp axes, see figures 3 and 4. These values were used to determine average luminance and uniformity.

A summary of measured results for the 3.2 inch x 3.3 inch prototype (excluding the extreme edges) are given in table 1. Uniformity is calculated as described in the above paragraph. To serve as a measure of the overall efficiency of the achieved results, the total power consumption including ballasts also is given. These results are for the Rohm and Haas Plex L 20% diffuser with 3M Brightness Enhancement Film, which we judged to be the best performance combination.

Summarized results for the 6 inch x 8 inch display are provided in table 2. The highest performance for this backlight was achieved with Rohm and Haas Plexiglas 2447 .060 inches thick diffuser with 3M Brightness Enhancement Film, to which these results apply. Also provided in table 2 for comparative purposes are data for the commercially available backlight purchased with the LCD, manufactured by Sharp. This backlight also uses parallel fluorescent lamps but does not utilize the high performance optical system described in this paper. Its uniformity is quite good over a narrow center section, but fall-off to a low level rapidly occurs elsewhere.

Where backlight specifications do not demand the luminances discussed here, similar optical techniques can be used with reduced lamp power or wider lamp spacing, maintaining high efficiency.

## Conclusion

As can be seen from the results presented in tables 1 and 2, very good performance has been achieved. High luminance levels have been developed with close to perfect uniformity. The performance is produced with low relative power consumption because of the high efficacy light sources used and the small losses in the optical system.

Table 1. 3.2 inch x 3.3 inch Prototype

| | |
|---|---|
| Average Luminance | Approx. 8300 fL |
| Luminance Uniformity | ± 3% |
| Power Requirement | 19.2 watts |

Table 2. 6 inch x 8 inch Backlights

| | Existing System | New Development |
|---|---|---|
| Average Luminance | 1093 fL | Approx. 9000 fL |
| Luminance Uniformity | See text | ± 3.5% |
| Power Requirement | 13.7 watts | 67 watts |
| Average Luminance/ Power | 79.8 | 134.0 |

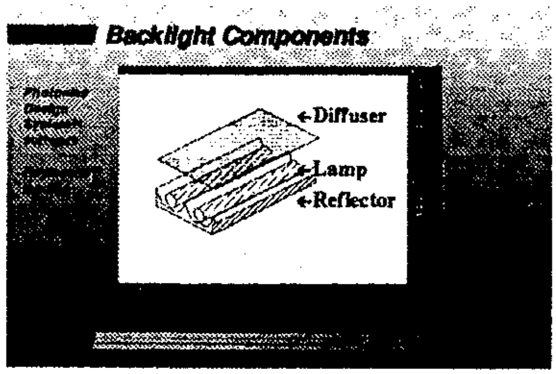


Figure 1. Backlight Components

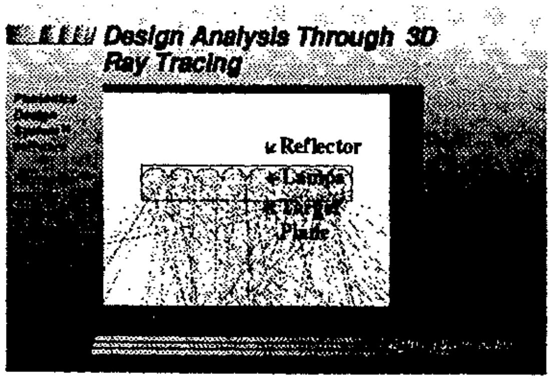


Figure 2. Example Ray Trace in Progress

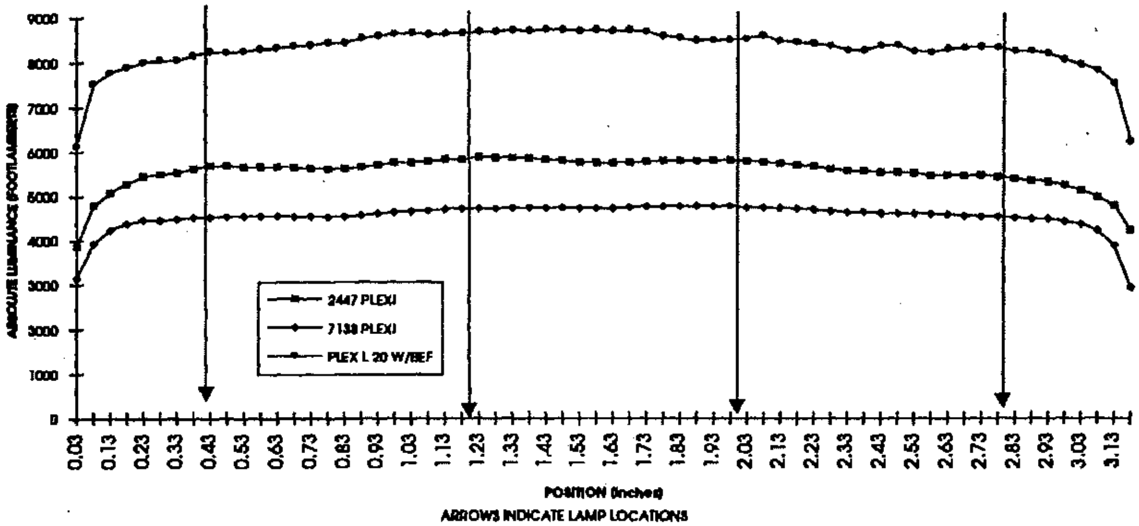


Figure 3. Measured Results for the 3.2 inch x 3.3 inch Prototype.

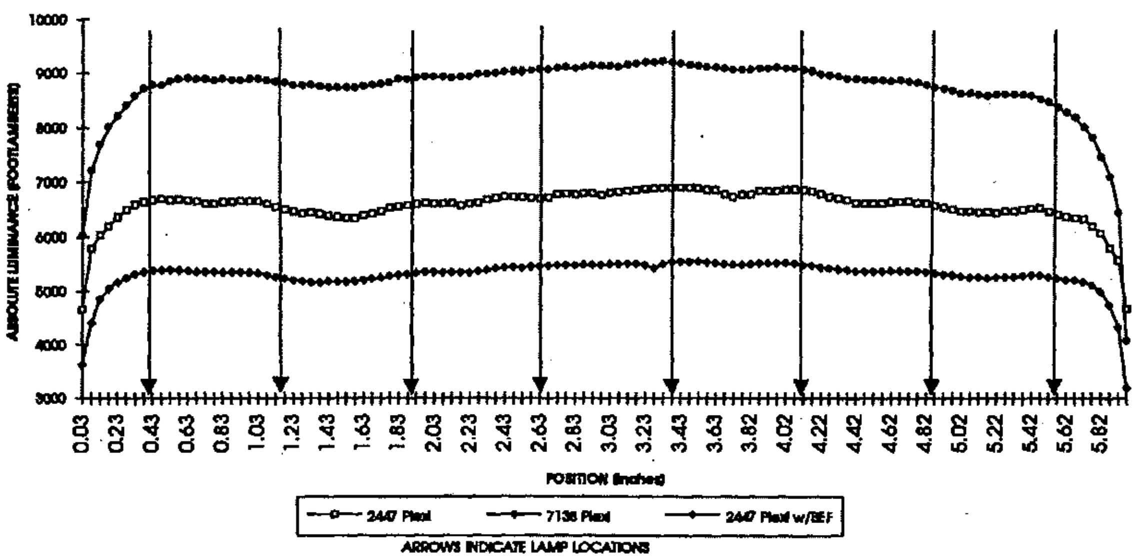


Figure 4. Measured Results for the 6 inch x 8 inch Prototype.

<u>References</u>

1. Lewin, Ian. "Principles of LCD Backlighting." Seminar lecture notes. SID 93. Society for Information Display.
2. Lewin, Ian. "How to Select a Backlight for LCD Displays." Seminar lecture notes. SID 94. Society for Information Display.

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Photonics Design System™ is a registered trademark of Lighting Sciences Inc., Scottsdale, Arizona.
AutoCAD™ is a registered trademark of Autodesk, Inc., Sausalito, CA.

# EXHIBIT 13

**To**

**DECLARATION OF ALEXANDER E. GASSER**
**IN SUPPORT OF**
**DEFENDANTS OPTREX'S, FUJIFILM'S, SAMSUNG SDI'S AND CITIZEN'S RESPONSIVE MEMORANDUM OF LAW IN SUPPORT OF THEIR PROPOSED CLAIM CONSTRUCTION**

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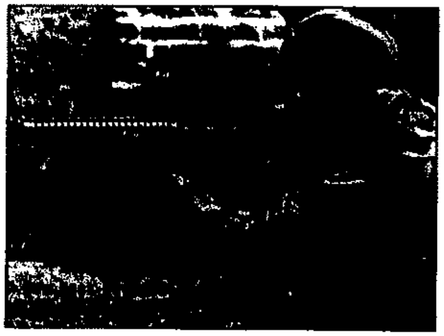
*COVER: A responsive yoke supplier has reduced manufacturing costs for the maker of this military thermal-imaging sight, which uses a neck-down CRT. As a result, the yoke manufacturer is helping the system maker to open civilian markets.*



Credit: Raytheon TI Systems

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- New LCD alignment techniques
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# Backlighting for Direct-View LCDs

*There's a lot to think about when selecting an LCD backlight, but many solutions are available.*

by Ian Lewin

SELECTING BACKLIGHTS for direct-view liquid-crystal displays (LCDs) is a more complex task than it may appear to be at first (Fig. 1). Part of the difficulty is the large number of backlighting techniques that are available, but the best available technique can only be selected when the end use of the display is fully understood and appropriate specifications – including the cost – are developed. Let's start off with some lighting parameters that are important for backlighting and then move on to the art of selecting backlights.

The ***efficacy*** or ***luminous efficiency*** [given in lumens per watt (lm/W)] is an important parameter for lamps, backlights, and complete display modules. The parameter indicates the amount of luminous output produced by a system for each watt of electrical power consumed. It is particularly important for notebook computers and other battery-operated systems since it directly affects the useful operating time from a single battery charge.

Designing an LCD module with high efficacy is particularly challenging because an LCD panel itself has low ***transmittance,*** which is the percentage of light that passes through the panel. Typical transmittance values for high-resolution LCD systems are given in Table 1. A substantial portion of the untransmitted light is absorbed in the polarizers and color filters of typical LCDs.

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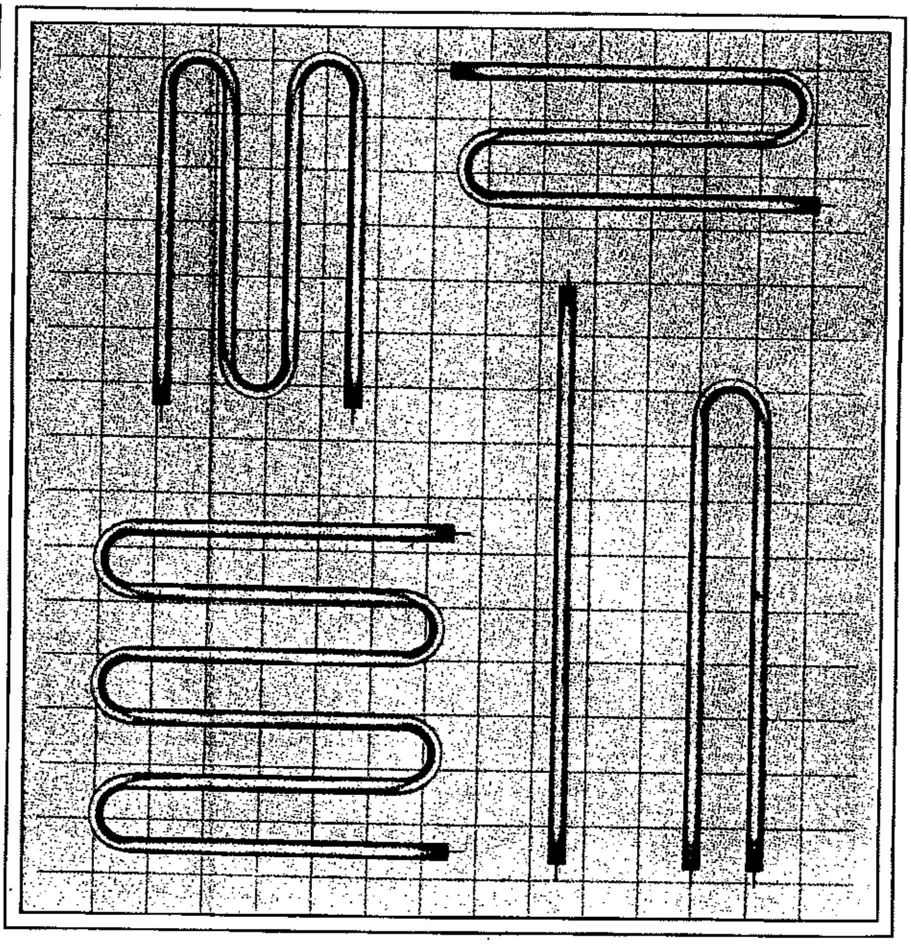

*Fig. 1: Straight, U-shaped, and serpentine fluorescent lamps are only the first of many choices to be made when designing an LCD backlight. (Illustration courtesy of LCD Lighting, Orange, Connecticut.)*



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## Vendors (partial listing)

### LCD Fluorescent-Lamp Manufacturers/Suppliers

*Light Sources, Inc.*
P.O. Box 948, Orange, CT 06477; 203/799-7877
*Voltarc Tubes, Inc.*
400 Captain Neville Dr., Waterbury, CT 06705; 203/578-4600
*JKL Components Corp.*
13343 Paxton St., Pacoima, CA 91331; 1-800-421-7244, 818/896-0019
*I. I. Stanley*
Los Angeles Sales Office, 2660 Barranca Pkwy., Irvine CA 92714; 714/222-0777
*Osram Sylvania*
100 Endicott St., Danvers, MA 01923; 508/777-1900
*LCD Lighting, Inc.*
37 Robinson Blvd., Orange, CT 06477; 203/795-1520

### Flat Fluorescent-Lamp Manufacturers

*Flat Candle Co.*
4725 B, Town Center Dr., Colorado Springs, CO 80516; 719/573-1880
*Thomas Electronics, Inc.*
100 Riverview Dr., Wayne, NJ 07470; 973/696-5200
*Sanyo Electric Co., Ltd.*
1-1, Dainichi-Higashimachi, Moriguchi, Osaka 570, Japan; +81-069-003-516

### Holographic Materials Manufacturers

*Physical Optics Corp.*
20600 Gramercy Pl., Bldg. 100, Torrance, CA 90501; 310/320-3088
*Kaiser Optical Systems, Inc.*
371 Parkland Plaza, P.O. Box 983, Ann Arbor, MI 48106; 313/665-8083

### Color Temperature

Light is spontaneously produced when a radiator such as a filament is heated to a high temperature. The color of the light emitted by such a "blackbody" radiator depends upon the temperature. Relatively low temperatures produce light biased to the red end of the spectrum, while high temperatures produce a bluish light. "Color temperature," expressed in Kelvin, therefore defines the spectral distribution of a filament lamp and is an important parameter.

The term is also widely applied to non-filament lamps, which is confusing. For non-filament lamps, it would be more accurate to substitute the expression "correlated color temperature." This is the temperature on the locus of blackbody temperatures (when these temperatures are plotted on the CIE chromaticity diagram) that is closest in appearance to the color coordinates of the non-blackbody radiator being characterized. While this can be a useful way to provide a general description of the color of a fluorescent or discharge lamp, it will differ radically from that of a blackbody source having the same color temperature. Because there is an infinite number of spectral power distributions that can produce any given correlated color temperature, the term is of limited use in LCD applications.

### Light-Loss Factors (LLFs)

Virtually all light sources exhibit lumen depreciation, or a reduction in light output, with burning hours. This usually takes the form of a fairly rapid fall-off during the first 100 or so hours of lamp operation, and then a gradual reduction to the end of life. Different forms of lamps have different lumen-depreciation rates, so this should be addressed when selecting lamps for a backlight design. Lamp manufacturers usually have lumen-depreciation curves available for their products.

### Lamp Life

All light sources have a life quoted by their manufacturers, but this life is statistically determined and does not represent a guarantee of the life of a particular lamp. The most commonly used definition of lifetime is the 50% failure point: the statistical point at which 50% of an "average" batch of lamps will fail. Thus, many lamps will fail prior to the rated lifetime.

In critical applications, such as in avionic systems, the practical life of the lamp may be considerably shorter than the rated life because lamp changeout is necessary for safety reasons to reduce the possibility of lamp failure in use.

Certain lamps have very long life but exhibit drastically reduced lumen maintenance late in life. Therefore, there may be a practical end-of-life when the lamp has not extinguished but is producing such a reduced light output that it is no longer able to meet luminance-level specifications.

Claims of lamp life must thus be treated with caution, and analyzed along with lumen-depreciation data and a recognition of the possible effects of premature lamp failure.

### Luminance Uniformity

Uniformity of luminance is generally expressed as a plus/minus percentage, but there is no universal definition of uniformity. While the plus/minus percentage expresses the allowable departure from the mean luminance, the precise definition of maximum, minimum, and mean is unclear. For backlighting systems using parallel fluorescent tubes, the maximum luminance is usually taken at a point directly in front of a tube, while the minimum is measured at the nearest point between tubes. But the true minimum usually lies at a corner of the LCD or along an edge. The method of measuring near-

**Table 1: Transmittances of High-Resolution LCD Systems**

| LCD Type | Transmittance (%) |
|---|---|
| Active matrix, color | 2–4 |
| Active matrix, monochrome | 10–12 |
| Passive matrix, color | 4–8 |
| Passive matrix, monochrome | 10–15 |

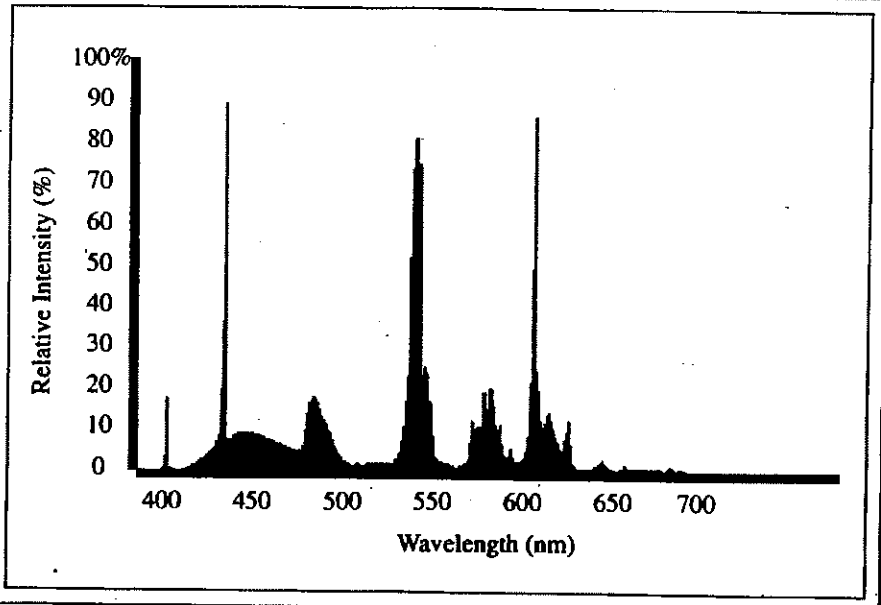


*Fig. 2: Tri-phosphor lamps show peaks in their spectral power distribution (SPD) at three distinct points in the spectrum. (Illustration courtesy of LCD Lighting, Orange, Connecticut.)*

est maximum and minimum points is suitable for characterizing uniformity in terms of a striping problem, but it does not define overall uniformity.

### Fluorescent-Lamp Characteristics

Most of today's LCD-backlighting systems rely on fluorescent lamps. These lamps work similarly to conventional fluorescent lamps used for the general illumination of buildings, but have been miniaturized for LCD applications.

The major components of a fluorescent lamp are the glass tube, the end electrodes, and the phosphor coating on the inside of the tube. The tube contains low-pressure mercury gas and a small amount of inert gas to assist in lamp starting. Applying a high voltage across the electrodes ionizes the gas and initiates a current flow between the two electrodes. This flow causes the gas to emit radiation, predominantly in the ultraviolet (UV) region (253.7 nm), which excites the phosphor on the inner wall of the tube. The wavelengths of light emitted depend on the type of phosphor used and are usually over a broad spectrum, producing a generally white appearance.

### Spectral Power Distribution

By alteration of the chemical composition and mix of the phosphors, the spectral power distribution (SPD) of the emitted light can be changed. "Cool" colors are produced by phosphors designed to emit a high proportion of blue light, while "warm" colors are generated by increased emission in the yellow and red spectral bands.

Over the last few years, considerable research has led to phosphors that convert UV radiation to visible light much more efficiently and provide improved lamp color. For commercial lighting applications, phosphors have been developed that produce SPDs which yield good color rendition. Among these are the various tri-phosphor lamps that show peaks in their SPD at three distinct points in the spectrum (Fig. 2). Manufacturers are interested in fluorescent-lamp phosphors with emission peaks close to the peak spectral transmittance values of the color matrix filters used in LCDs. By coordinating lamp spectral output with LCD spectral characteristics, it should be possible to considerably improve system efficiency. Lamps with enhanced spectral characteristics for LCD applications are now available.

### Ballasts

Electrical discharge through a gas must be controlled externally to prevent the flow of a very high electrical current that will burn out the lamp almost instantaneously. The lamp circuit therefore contains a ballast, which acts as a current-limiting device and also provides the high starting voltage needed for ionization. The limited current flow is kept close to that specified for steady-state operation of the lamp.

Ballasts may be either magnetic or electronic. The magnetic ballast is a highly reactive transformer that creates a high voltage in its secondary coil to start the lamp, but then limits the current flow because of its very high reactance. The electronic ballast uses electronic components to achieve a similar result.

### Hot or Cold Cathode?

Fluorescent lamps come in hot- and cold-cathode types. The hot-cathode lamp uses electrodes that are small heater coils. A small voltage is applied across each coil, heating the electrode and thermally emitting a large quantity of electrons. This is an efficient method of creating the electron flow through the tube because it keeps the voltage drop at the cathode (the cathode fall) to only a few volts.

Cold-cathode lamps don't have a coil; their electrodes consist of unheated cylinders or plates. They exhibit a high cathode fall during operation and are thus less efficient than hot-cathode lamps.

Both hot- and cold-cathode lamps are being applied in LCD-backlighting systems. The

**Table 2: Characteristics of Hot- and Cold-Cathode Fluorescent Lamps**

| Parameter | Hot Cathode | Cold Cathode |
|---|---|---|
| Starting voltage | Lower | Higher |
| Life (thousands of hours) | 5–15 | 10–20 |
| Vibration and impact resistance | Poorer | Better |
| Cathode losses | Low (15 V) | High (150 V) |
| Efficacy* | Higher | Lower |

*Efficacy, given in lumens per watt, depends on many characteristics, such as arc length, tube diameter, power loading (W/cm), phosphor type, and lamp shape, in addition to cathode type. Complete performance specifications are available from various manufacturers.

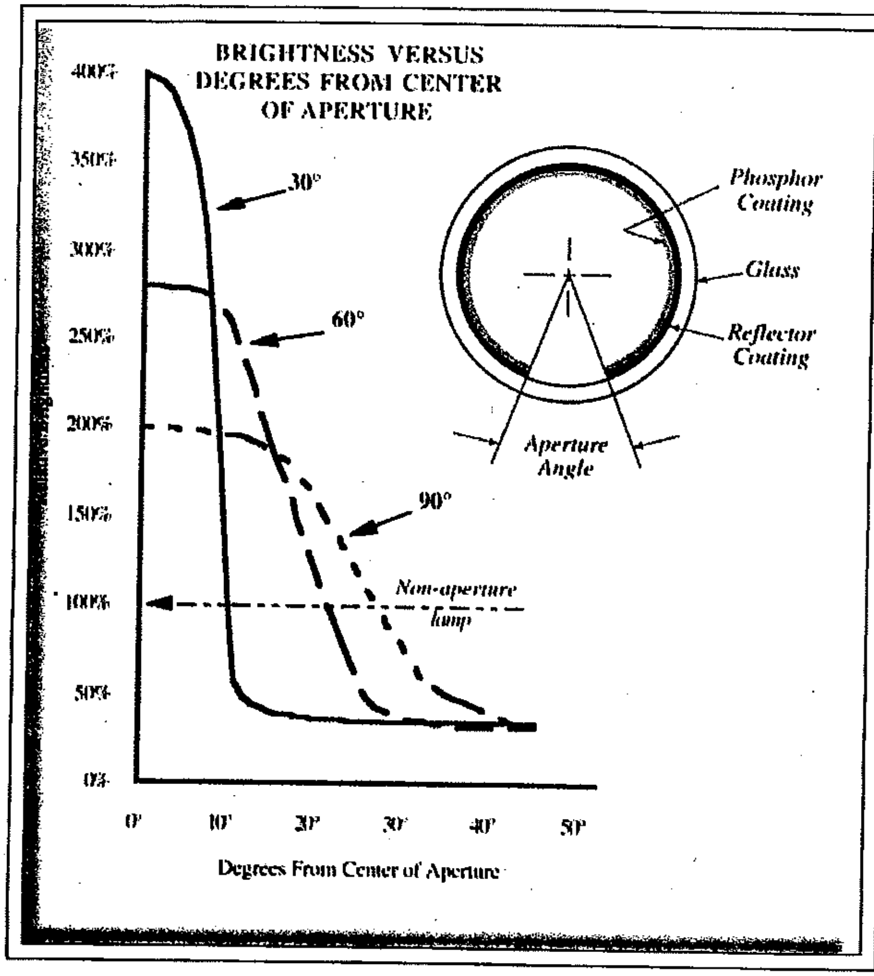


*Fig. 3: Aperture lamps have a small gap in the reflector and phosphor layers that allows light to be emitted through the gap. Inter-reflection of light within the tube causes the output of light through the window to be increased up to 10 times that of a non-reflectorized lamp, which allows the light projected into an edge-lighting system to be increased substantially. (Illustration courtesy of LCD Lighting, Orange, Connecticut.)*

two lamp types have substantially different characteristics, with each having its own advantages and disadvantages (Table 2).

## Temperature Characteristics

Fluorescent lamps have high-temperature sensitivity in both their starting voltages and lumen output. Low temperatures increase the breakdown voltage (the voltage required to start the lamp) and ballasts designed for starting under normal ambient temperature are likely to be unsatisfactory.

At both low and high temperatures, fluorescent lamps give substantially reduced lumen output. The actual temperature characteristics are dependent upon the specific lamp type, and must be checked prior to selecting lamps that must operate over a wide range of ambient temperatures. Supplemental heating circuits may be required.

## Aperture Fluorescent Lamps

Normal fluorescent lamps emit light in all directions, with approximately equal intensity in directions perpendicular to the lamp surface. In certain applications, such as edge lighting, the goal is to project light into a thin sheet of transmitting material. In such applications, it may be advantageous to use an aperture or reflector fluorescent lamp, a modified type that creates a sharply increased intensity in a narrow range of directions.

Aperture lamps have a white reflective layer between the phosphor and glass tube that covers most of the lamp surface. A small gap in the reflector and phosphor layers allows light to be emitted through the gap (Fig. 3). Inter-reflection of light within the tube causes the output of light through the window to be increased up to 10 times that of a non-reflectorized lamp. This allows the light projected into an edge-lighting system to be increased substantially.

## Light-Control Systems

All LCD-backlighting systems must produce relatively uniform luminance in a plane parallel to and behind the LCD. There are many techniques for light control that help produce backlights which approach the ideal flat sheet of light – and more are under investigation.

***Flat Fluorescent Panel.*** The simplest form of flat fluorescent panel, which has been widely used, depends on a serpentine lamp, which creates the effect of a row of parallel tubes. The spacing between the tube segments affects the uniformity of the light, with a wide spacing producing unsatisfactory bands of high and low luminance. This may be overcome by using a diffuser between the lamp and LCD, which evens out the luminance. Very good uniformity requires a material that strongly diffuses the light, but the diffuser's transmittance is generally reduced if the diffusion is high. So, there is a tradeoff between uniformity and optical efficiency - and, therefore, the luminance level.

Recently, special lamps have been developed that operate on principles similar to those of the fluorescent tube, but which are different in construction. One form of flat fluorescent lamp is similar to the bent serpentine

### Table 3: Typical Specification of LCD Backlight for Computer Monitor

| | |
|---|---|
| Active Area | 11 × 7 in. |
| Average luminance | 4000 fL |
| Luminance uniformity | ±15% |
| Dimming range | 100:1 |
| Lamp life | 10,000 hours |

lamp except that it is not a tube. Formed from front and rear glass moldings that are joined together, a serpentine discharge path is created in a one-piece lamp.

Another flat fluorescent lamp creates a sheet of plasma that activates the fluorescent phosphor with good uniformity. These lamps are available in a variety of sizes up to 6 × 8 in.; the thickness is typically 0.40 in. or less.

Manufacturers' claims for the performance of flat fluorescent lamps vary depending upon the variety. A luminance of 20,000 cd/m$^2$ (6000 fL) has been claimed for a serpentine-channel lamp, while the claimed luminance of flat plasma lamps ranges from 3500 cd/m$^2$ (1000 fL) to 10,000 cd/m$^2$ (3000 fL).

***Edge-Lighting Systems.*** Edge-lighting methods do not use lamps behind the LCD. Instead, they use lights mounted around the periphery of the display and an optical system to carry and emit light behind the LCD. Because the light-generating length is limited by the size of the LCD edges, and because edge-lighting has relatively low optical efficiency, edge-lighting techniques do not generally produce very high luminance. However, they have the considerable advantage of very shallow depth because there are no lamps behind the LCD. This makes the method applicable to products such as laptop computers, where a thin profile is important and power consumption is low.

One way of getting light from an edge-lighting system behind the display is through a ***light pipe.*** A sheet of plastic is placed behind the LCD and fluorescent lamps are placed along one or more edges of the sheet. Light enters the sheet and is transmitted across by total internal reflection. Light is emitted only when rays hit a discontinuity in the plastic surface that interrupts the total internal reflection.

A popular kind of discontinuity is an array of bumps or dots on the surface of the plastic sheet facing the LCD. The spacing of the dots determines the luminance in a particular area, so dot density can be varied to change the luminance. A high dot density is used in areas remote from the lamp and a low dot density is used near the lamp to provide luminance uniformity. A diffuser may be needed between the light pipe and the LCD to hide the dot pattern.

A prismatic form of light pipe has been developed, in which prisms are formed in the plastic surface to produce light emission. This method is claimed to produce a substantial increase in luminance through higher optical efficiency. Luminances up to 5500 cd/m$^2$ (1600 fL) have been produced.

***Reflector Systems.*** The development of narrow-diameter straight fluorescent lamps permits the fabrication of thin backlighting systems based on parallel tubes. We now have reflectors that capture light from the sides and rear of the tubes, which do not face the LCD, and redirect that light to the low-luminance areas between the fluorescent lamps. Reflector designs have been produced that reduce the striation effects to a minimum, and the stripes can be completely removed by placing a high-transmittance diffuser between the backlight and the LCD.

## Light-Control Materials

Between the backlight and the LCD system, it is usual to place a material that diffuses the light. In addition to producing a smooth lighted pattern from the backlight, the material can perform other useful functions if it has optical properties that enhance the backlight's performance.

Where normal diffusion is desired, the thickness and density of the diffuser will affect the amount of diffusion and the diffuser's transmittance. Lambertian diffusion distributes the light intensity in proportion to the cosine of the viewing angle, and thus provides constant luminance.

Usually, however, the vertical and horizontal angles of view are limited to substantially less than ±90°. By concentrating light in a generally forward direction, the intensity and luminance close to the 0° viewing angle can be substantially increased, although the width of the effective viewing angle is decreased. This can be achieved by using prismatic lenses or holographic materials instead of a diffuser.

New materials for controlled diffusion are the result of holographic processes. Such materials allow the degree and pattern of diffusion to be specified, rather than evolving from the random scattering of light produced by conventional diffusers.

Experimenting with different diffuser types is normally required when developing backlighting systems because each type of backlight design has its own characteristics regarding viewing angle, luminance uniformity, and luminance level. The designer generally wants to implement a uniformity of luminance that just meets specifications and does so with the minimum possible diffusion so as to maximize the optical efficiency of the system.

## Designing Backlights

The design of illumination systems has traditionally been carried out using ray-trace methods. The direction of light rays can be readily determined using well-known laws of optics for both reflective and refractive media, but designing a complex light-distribution system for an LCD backlight – which may involve many lamps and optical elements – with traditional ray-tracing can be extremely time-consuming.

Fortunately, personal-computer software can now perform illumination-system design, permitting a larger number of design iterations. With customers demanding increasing efficiency and performance, advanced software techniques will be essential for designing the next generation in LCD-backlighting systems. ■

# EXHIBIT 14

To

DECLARATION OF ALEXANDER E. GASSER
IN SUPPORT OF
DEFENDANTS OPTREX'S, FUJIFILM'S, SAMSUNG SDI'S AND CITIZEN'S RESPONSIVE MEMORANDUM OF LAW
IN SUPPORT OF THEIR PROPOSED CLAIM CONSTRUCTION

REDACTED

# EXHIBIT 15

To

DECLARATION OF ALEXANDER E. GASSER
IN SUPPORT OF
DEFENDANTS OPTREX'S, FUJIFILM'S, SAMSUNG SDI'S AND CITIZEN'S RESPONSIVE MEMORANDUM OF LAW
IN SUPPORT OF THEIR PROPOSED CLAIM CONSTRUCTION

REDACTED

# EXHIBIT 16

To

DECLARATION OF ALEXANDER E. GASSER
IN SUPPORT OF
DEFENDANTS OPTREX'S, FUJIFILM'S, SAMSUNG SDI'S AND
CITIZEN'S RESPONSIVE MEMORANDUM OF LAW
IN SUPPORT OF THEIR PROPOSED CLAIM CONSTRUCTION

**AKEVA L.L.C., Plaintiff-Appellant, v. ADIDAS-SALOMON AG, Defendant, and ADIDAS AMERICA, INC., Defendant-Appellee.**

**06-1090**

**UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT**

*208 Fed. Appx. 861*; *2006 U.S. App. LEXIS 28195*

**November 13, 2006, Decided**

**NOTICE:** [**1] THIS DECISION WAS ISSUED AS UNPUBLISHED OR NONPRECEDENTIAL AND MAY NOT BE CITED AS PRECEDENT. PLEASE REFER TO THE RULES OF THE FEDERAL CIRCUIT COURT OF APPEALS FOR RULES GOVERNING CITATION TO UNPUBLISHED OR NONPRECEDENTIAL OPINIONS OR ORDERS.

**SUBSEQUENT HISTORY:** Rehearing denied by, Rehearing, en banc, denied by *Akeva L.L.C. v. Adidas-Salomon AG, 2007 U.S. App. LEXIS 2329 (Fed. Cir., Jan. 12, 2007)*
US Supreme Court certiorari denied by *Akeva L.L.C. v. Adidas Am., Inc., 2007 U.S. LEXIS 7743 (U.S., June 18, 2007)*

**PRIOR HISTORY:** *Akeva L.L.C. v. Adidas Am., Inc., 2005 U.S. Dist. LEXIS 11213 (M.D.N.C., May 17, 2005)*

**DISPOSITION:** Affirmed.

**CASE SUMMARY:**

**PROCEDURAL POSTURE:** Plaintiff licensor appealed the order of the United States District Court for the Middle District of North Carolina, which construed the term "secured" in the patents and granted defendant shoe company summary judgment of non-infringement. The licensor conceded that, if the claims were construed to cover only detachable or rotatable heels, the company did not infringe its claims.

**OVERVIEW:** The licensor of patents describing "flexible member" improvements to athletic shoe heels accepted entry of summary judgment of non-infringement because the company's shoes had permanently-fixed soles. The patents claimed a rear sole secured below the heel region of the upper or below a portion of the upper. The licensor alleged that the ordinary meaning of the claim should have been given to the term "secured" and would have encompassed permanent, removable, and rotatable soles. The court did not disturb the district court's claim construction because the specification in the first patent, when read as a whole, clearly demonstrated that the invention's scope was shoes with detachable heels, the primary feature, which may have included an optional flexible plate. Finding that "secured" only applied to shoes with detachable heels did not take the term outside its ordinary meaning; rather, the term was interpreted in accordance with the specification and did not allow for removability. The court found that the "permanently attached" language in the second patent's specification disclaimed shoes with heels that were permanently fixed (could not be interchanged) and did not rotate.

**OUTCOME:** The court affirmed.

**LexisNexis(R) Headnotes**

***Patent Law > Infringement Actions > Claim Interpretation > General Overview***
***Patent Law > Infringement Actions > Summary Judgment > Appeals***
[HN1] A district court's patent claim construction findings are reviewed de novo on appeal. A grant of summary judgment is also reviewed de novo.

***Patent Law > Infringement Actions > Claim Interpretation > Aids***

[HN2] Claim language governs claim interpretation. Claim terms, however, are construed in light of the specification. The ordinary meaning of a term may be narrowed when interpreted in light of the specification.

***Patent Law > Infringement Actions > Claim Interpretation > Aids***

[HN3] The construction that stays true to the claim language and most naturally aligns with the patent's description of the invention will be, in the end, the correct construction. In other words, an inventor cannot get more than he or she invents. While each term standing alone can be construed as having varying degrees of breadth, each term must be construed to implement the invention described in the specification.

***Patent Law > Infringement Actions > Claim Interpretation > Aids***

[HN4] Where the specification makes clear that the invention does not include a particular feature, that feature is deemed to be outside the reach of the claims of the patent, even though the language of the claims, read without reference to the specification, might be considered broad enough to encompass the feature in question.

**JUDGES:** Before MICHEL, Chief Judge, PLAGER, Senior Circuit Judge, and RADER, Circuit Judge.

**OPINION BY:** RADER

**OPINION**

[*862] RADER, *Circuit Judge.*

Akeva L.L.C. (Akeva) is a company which has been assigned and licenses a portfolio of footwear patents. Akeva sued adidas America, Inc. (adidas) for infringement of certain claims of two of its patents: *U.S. Patent No. 6,662,471* (the *'471 patent*) and *U.S. Patent No. 6,604,300* (the *'300 patent*). [1] These patents describe improvements to athletic shoe heels. According to Akeva, the specifications of the *'300* and *'471 patent* describe a "flexible member" [2] improvement that can be incorporated in rear soles that are detachable, or rotatable, or permanently secured. The district court construed these patents as covering shoes with rotatable or detachable rear soles only. *See Akeva L.L.C. v. adidas Am., Inc., 1:03CV01207, 2005 U.S. Dist. LEXIS 11213 (M.D.N.C. May 17, 2005)* (*Claim Construction Decision*); [**2] *Akeva L.L.C. v. adidas Am., Inc., 385 F. Supp. 2d 559 (M.D.N.C. 2005)* (*Reconsideration Decision*) [3]. Because adidas shoes have permanently-fixed rear soles that do not rotate, Akeva accepted entry of summary judgment of non-infringement and appealed the district court's claim construction to this court. *Akeva L.L.C. v. Adidas Am., Inc., 385 F. Supp. 2d 559 (M.D.N.C. 2005)* (*Final Judgment*). Because the district court correctly construed the term "secured," the summary judgment of non-infringement is *affirmed.*

1 Akeva asserted claims 93, 94, 100-106, 109, 117, 118, 121-154, 192-194, and 204-232 of the *'300 patent*, and claims 1-32 of the *'471 patent* against adidas.

2 "Flexible member" is an inclusive term given to describe the U-shaped member of the *'471 patent* and the flexible plate of the *'300 patent.*

3 The district court reconsidered its claim construction decision in light of this court's intervening decision in *Phillips v. AWH Corp., 415 F.3d 1303 (Fed. Cir. 2005)* (en banc), but did not deviate from its original construction.

I.

[HN1] A district court's claim construction findings are reviewed de novo on appeal. *Cybor Corp. v. FAS Techs. Inc., 138 F.3d 1448, 1456 (Fed. Cir. 1998)* [**3] (en banc). A grant of summary judgment is also reviewed de novo. *Bell Atl. Network Servs., Inc. v. Covad Commc'ns Group, Inc., 262 F.3d 1258, 1266-67 (Fed. Cir. 2001).* This court has jurisdiction under *28 U.S.C. § 1295(a)(1).*

[*863] The central issue of this appeal is the meaning of the term "secured" as it is used in the *'300* and *'471 patents.* Claim 93 of the *'300 patent,* for example, claims:

A shoe comprising:

an upper having a heel region;

a rear sole *secured* below the heel region of the upper; and

a flexible plate having upper and lower

> surfaces and positioned between at least a portion of the heel region of the upper. . . .

*'300 patent*, col. 20 ll.29-43 (emphasis added).

The *'471 patent* also uses the term "secured." For example, claim 1 states:

> A shoe comprising:
>
> an upper, and
>
> a rear sole *secured* below a portion of the upper, the rear sole comprising:
>
> a member having a top wall with a lower surface . . . the member having a bottom wall . . . the forward regions of the top and bottom walls being connected at a close end by a curved wall. . . .

*'471 patent*, col. 13 ll.6-50 (emphasis [**4] added).

Akeva argues that the ordinary meaning of the claim should be given to the term and that the ordinary meaning would encompass permanent, removable, and rotatable soles to athletic shoes. adidas argues that the specifications of the *'300* and *'471 patents* disavow rear soles that are not detachable or rotatable.

This court construes claims in accordance with the principles set forth in *Phillips v. AWH Corp., 415 F.3d 1303 (Fed. Cir. 2005)* (en banc). [HN2] Claim language governs claim interpretation. *Id. at 1312*. Claim terms, however, are construed in light of the specification. *Id. at 1315*. The ordinary meaning of a term may be narrowed when interpreted in light of the specification. *Id. at 1316.*

A. The *'471 Patent*

The *'471 patent* is directed to athletic soles with interchangeable soles which "provide extended and more versatile life and better performance in terms of cushioning and spring." Col. 1 ll.13-17. The *'471 patent* states that "an athletic shoe can be changed dramatically if it is simply given interchangeable rear soles." *Id.* at col. 2 ll.54-55. In particular, the specification describes shoes with [**5] "interchangeable/detachable rear soles" to address problems with uneven wear patterns. *Id.* at ll.14-15, 26-27. While Akeva argues that the invention of the *'471 patent* is the flexible membrane, the language of the *'471* specification specifically states that the invention of the *'471 patent* is an athletic shoe with a detachable heel: "However, in a radical departure from conventional shoes, the shoe of the present invention incorporates a heel structure, including *a detachable rear sole*, that significantly alleviates heel wear problems associated with conventional soles and provides enhanced cushioning and/or spring.". *Id.* at col. 4 ll.56-61 (emphasis added).

Akeva argues that the catch-all phrase at the end of the *'471 patent* specification, which states "[t]hus, it is intended that the present invention cover all possible combinations of the features shown in the different embodiments, as well as modifications and variations of this invention, provided they come within the scope of the claims and their equivalents," precludes a claim construction which comprises only detachable heels. Col. 13 ll.1-5. No embodiments, however, of the *'471 patent* include permanently attached [**6] heels. Of course, the absence of an embodiment does not necessarily exclude that embodiment from the scope of the invention. *Liebel-Flarsheim* [*864] *Co. v. Medrad, Inc., 358 F.3d 898, 906 (Fed. Cir. 2004)*. But here, the specification when read as a whole clearly demonstrates that the scope of the invention is athletic shoes with detachable heels which may include an optional flexible plate. *See '471 patent*, col. 4 ll.62-col. 5 ll.4 ("An embodiment of the heel structure . . . includes . . . a rear sole detachable secured to the rear sole support. . . . In addition, the heel structure may include a flexible plate for providing spring to the heel of the user and reducing wear caused by midsole compression."). Akeva cites *Golight, Inc. v. Wal-Mart Stores, Inc., 355 F.3d 1327, 1331 (Fed. Cir. 2004)*, in which the court found no disclaimer where the specification states the invention "includes" some feature where it is only one of several features described as significant or important. However, this case is distinguishable because the detachable sole of the *'471 patent* is not one of several features, it is the primary feature of the invention.

Indeed, when [**7] the *'471 patent* uses the term "secured," it uses it to describe a rear sole which is "detachably secured." Col. 3 ll.14-17. Finding that the

term "secured" applies only to shoes with detachable heels does not take the term outside its ordinary meaning. Rather, the term is interpreted as it is used in accordance with the specification; "secured" does allow for removability. As this court has stated in *Phillips*, "[t]he [HN3] construction that stays true to the claim language and most naturally aligns with the patent's description of the invention will be, in the end, the correct construction." *415 F.3d at 1316*. In other words, an inventor cannot get more than he or she invents. *On Demand Mach. Corp. v. Ingram Indus. Inc., 442 F.3d 1331, 1344 (Fed. Cir. 2006)* (citing *Phillips, 415 F.3d at 1316* and *Autogiro Co. of Am. v. United States, 384 F.2d 391, 397-98, 181 Ct. Cl. 55(1967))* ("[while] each term standing alone can be construed as having varying degrees of breadth, each term must be construed to implement the invention described in the specification"). The district court construed this term as used in the *'471 patent* to mean "a rear sole [**8] detachably secured below a portion of the upper." *Claim Construction Decision 2005 U.S. Dist. LEXIS 11213 at 35, [slip op] at 28*. As such, this court will not disturb the district court's claim construction that the *'471 patent* covers shoes with detachable heels.

B. The *'300 Patent*

The *'300 patent* specification also discloses athletic shoes with extended life by improving the rear sole such that the rear sole is rotatable, detachable, or both. The *'300 patent* notes that the soles of prior art athletic shoes tend to wear out faster than the shoe itself. Col. 1 ll.2-42. Further, athletic shoe performance cushioning also tends to wear out faster than the shoe itself. *Id.* at ll. 44-46. In order to solve this problem, the *'300 patent* specification discloses shoes that can be rotated into different positions to allow for more even wear to the sole of the athletic shoe. Col. 6 ll.56-59. Or, in a preferred embodiment, the rear sole can be detached, allowing the athletic shoe owner to change the sole depending on the cushioning and other features desired for a particular activity. Col. 4 ll.42-46.

The district court construed the term "secured" in the *'300 patent* to mean "selectively or permanently fastened, but not permanently-fixed [**9] into position." *Claim Construction Decision 2005 U.S. Dist. LEXIS 11213 at 32, [slip op] at 25*. Akeva argues on appeal that the invention of the *'300 patent* is a flexible plate that can be used in shoes with rotatable, detachable, or permanently fixed heels. To support its argument for this claim interpretation here, Akeva points to language in the *'300 patent* specification which states "[t]he [*865] flexible region also need not be used only in conjunction with a detachable rear sole, but can be used with permanently attached rear soles as well." Col. 10 ll.12-16. Akeva also argues that a related patent, *U.S. Patent 5,560,126* (the *'126 patent*), claims a "detachably secured" rear sole and a rear sole that allows for "selective rotation" and that this supports its claim that such soles are not the claimed invention of the *'300 patent*. Thus, Akeva argues, the asserted claims of the *'300 patent* cover permanently-fixed soles that will or will not rotate and which contains a flexible plate.

In *SciMed Life Systems Inc. v. Advanced Cardiovascular Systems Inc., 242 F.3d 1337, 1341 (Fed. Cir. 2001)*, this court stated "[w]here [HN4] the specification makes clear that the invention does not include a particular feature, that [**10] feature is deemed to be outside the reach of the claims of the patent, even though the language of the claims, read without reference to the specification, might be considered broad enough to encompass the feature in question." In *SciMed*, the language of the specification contained a "broad and unequivocal" disclaimer of dual lumens in catheters. *242 F.3d at 1344*. The language of the *'300 patent* specification is less equivocal than that in *SciMed*. Here, the *'300 patent* states contains the "all embodiments" language discussed in *SciMed*: "[i]n all embodiments, the invention includes mechanical means for selectively locking the rear sole relative to the rear sole support and upper of the shoe." Col 7 ll.17-20. The "all embodiments" language of the *'300 patent* specification bowever, appears at first blush to conflict with the "permanently attached rear soles" language, creating a less equivocal disclaimer than that of *SciMed*. Col. 7 ll.17-20; col. 10 ll.12-16.

Nevertheless, the "permanently attached" language, when read in the context of the specification, supports a finding that the *'300 patent* specification disclaims permanently attached rear soles that [**11] do not at least rotate. *Phillips, 415 F.3d at 1316*. The "permanently attached" language in the specification contemplates shoes with heels that are permanently fixed (cannot be interchanged) but are rotatable. For example, the *'300 patent* specification states that "the rear sole may not be removable but only rotatably positionable." Col. 7 ll.42-43, see also col 6:58-63, col. 7 ll.35-44; Fig. 3 of the

*'300 patent*. In addition, the *'300 patent* specification discusses as a problem of prior art shoes with heels the shoe owner is "stuck" with. Col. 2 ll.2-3. In order to solve this problem and other problems, the *'300 patent* contemplates athletic shoes with rear soles that can be rotated or replaced. Col. 6 ll.33-45.

As the district court noted: "Akeva has cited no statement in the *'300 Patent*'s specification, and this court has found none, that would contemplate a rear sole that is permanently locked into position." *Claim Construction Decision 2005 U.S. Dist. LEXIS 11213 at 31, [slip op] at 25*. Accordingly, one skilled in the art reading the specification of the *'300 patent* specification would understand the term "secured" as used in the *'300 patent* to mean shoes with rear soles that are secured to the shoe, [**12] but not permanently fixed.

Further, while this court has considered prosecution of earlier patents in the construction of claim terms used in later issued patents, *see Microsoft Corp. v. Multi-Tech Sys., Inc., 357 F.3d 1340, 1349-50 (Fed. Cir. 2004)*, in those cases, the patents had the same specification. Here, the *'126 patent* on which Akeva relies has a different disclosure than the *'300 patent*.

Therefore, this court construes the term "secured" in accordance with the district court.

[*866] II. Infringement

Akeva concedes that if the claims are construed to only cover detachable or rotatable heels, adidas does not infringe its claims. Thus, this court affirms the district court's entry of summary judgment of non-infringement in favor of adidas.

# EXHIBIT 17

To

DECLARATION OF ALEXANDER E. GASSER
IN SUPPORT OF
DEFENDANTS OPTREX'S, FUJIFILM'S, SAMSUNG SDI'S AND CITIZEN'S RESPONSIVE MEMORANDUM OF LAW
IN SUPPORT OF THEIR PROPOSED CLAIM CONSTRUCTION

REDACTED

# EXHIBIT 18

**To**

**DECLARATION OF ALEXANDER E. GASSER**
**IN SUPPORT OF**
**DEFENDANTS OPTREX'S, FUJIFILM'S, SAMSUNG SDI'S AND CITIZEN'S RESPONSIVE MEMORANDUM OF LAW**
**IN SUPPORT OF THEIR PROPOSED CLAIM CONSTRUCTION**

REDACTED

# EXHIBIT 19

**To**

**DECLARATION OF ALEXANDER E. GASSER**
**IN SUPPORT OF**
**DEFENDANTS OPTREX'S, FUJIFILM'S, SAMSUNG SDI'S AND CITIZEN'S RESPONSIVE MEMORANDUM OF LAW IN SUPPORT OF THEIR PROPOSED CLAIM CONSTRUCTION**

# Manual of PATENT EXAMINING PROCEDURE

Original Eighth Edition, August 2001
Latest Revision September 2007

U.S. DEPARTMENT OF COMMERCE
United States Patent and Trademark Office

*v. Finney*, 34 F.3d 1058, 1063, 32 USPQ2d 1115, 1120 (Fed. Cir. 1994)).

Thus, while an applicant may on occasion need to provide evidence to show that an invention will work as claimed, it is improper for Office personnel to request evidence of safety in the treatment of humans, or regarding the degree of effectiveness. See *In re Sichert*, 566 F.2d 1154, 196 USPQ 209 (CCPA 1977); *In re Hartop*, 311 F.2d 249, 135 USPQ 419 (CCPA 1962); *In re Anthony*, 414 F.2d 1383, 162 USPQ 594 (CCPA 1969); *In re Watson*, 517 F.2d 465, 186 USPQ 11 (CCPA 1975); *In re Krimmel*, 292 F.2d 948, 130 USPQ 215 (CCPA 1961); *Ex parte Jovanovics*, 211 USPQ 907 (Bd. Pat. App. & Inter. 1981).

### VI. TREATMENT OF SPECIFIC DISEASE CONDITIONS

Claims directed to a method of treating or curing a disease for which there have been no previously successful treatments or cures warrant careful review for compliance with 35 U.S.C. 101. The credibility of an asserted utility for treating a human disorder may be more difficult to establish where current scientific understanding suggests that such a task would be impossible. Such a determination has always required a good understanding of the state of the art as of the time that the invention was made. For example, prior to the 1980's, there were a number of cases where an asserted use in treating cancer in humans was viewed as "incredible." *In re Jolles*, 628 F.2d 1322, 206 USPQ 885 (CCPA 1980); *In re Buting*, 418 F.2d 540, 163 USPQ 689 (CCPA 1969); *Ex parte Stevens*, 16 USPQ2d 1379 (Bd. Pat. App. & Inter. 1990); *Ex parte Busse*, 1 USPQ2d 1908 (Bd. Pat. App. & Inter. 1986); *Ex parte Krepelka*, 231 USPQ 746 (Bd. Pat. App. & Inter. 1986); *Ex parte Jovanovics*, 211 USPQ 907 (Bd. Pat. App. & Inter. 1981). The fact that there is no known cure for a disease, however, cannot serve as the basis for a conclusion that such an invention lacks utility. Rather, Office personnel must determine if the asserted utility for the invention is credible based on the information disclosed in the application. Only those claims for which an asserted utility is not credible should be rejected. In such cases, the Office should carefully review what is being claimed by the applicant. An assertion that the claimed invention is useful in treating a symptom of an incurable disease may be considered credible by a person of ordinary skill in the art on the basis of a fairly modest amount of evidence or support. In contrast, an assertion that the claimed invention will be useful in "curing" the disease may require a significantly greater amount of evidentiary support to be considered credible by a person of ordinary skill in the art. *In re Sichert*, 566 F.2d 1154, 196 USPQ 209 (CCPA 1977); *In re Jolles*, 628 F.2d 1322, 206 USPQ 885 (CCPA 1980). See also *Ex parte Ferguson*, 117 USPQ 229 (Bd. Pat. App. & Inter. 1957).

In these cases, it is important to note that the Food and Drug Administration has promulgated regulations that enable a party to conduct clinical trials for drugs used to treat life threatening and severely-debilitating illnesses, even where no alternative therapy exists. See 21 CFR 312.80-88 (1994). Implicit in these regulations is the recognition that experts qualified to evaluate the effectiveness of therapeutics can and often do find a sufficient basis to conduct clinical trials of drugs for incurable or previously untreatable illnesses. Thus, affidavit evidence from experts in the art indicating that there is a reasonable expectation of success, supported by sound reasoning, usually should be sufficient to establish that such a utility is credible.

## 2111 Claim Interpretation; Broadest Reasonable Interpretation [R-5]

### CLAIMS MUST BE GIVEN THEIR BROADEST REASONABLE INTERPRETATION

During patent examination, the pending claims must be "given their broadest reasonable interpretation consistent with the specification." >The Federal Circuit's *en banc* decision in *Phillips v. AWH Corp.*, 415 F.3d 1303, 75 USPQ2d 1321 (Fed. Cir. 2005) expressly recognized that the USPTO employs the "broadest reasonable interpretation" standard:

> The Patent and Trademark Office ("PTO") determines the scope of claims in patent applications not solely on the basis of the claim language, but upon giving claims their broadest reasonable construction "in light of the specification as it would be interpreted by one of ordinary skill in the art." *In re Am. Acad. of Sci. Tech. Ctr.*, 367 F.3d 1359, 1364[, 70 USPQ2d 1827] (Fed. Cir. 2004). Indeed, the rules of the PTO require that application claims must "conform to the invention as set forth in the remainder of the specification and the terms and phrases used in the claims must find clear support or antecedent basis in the description so that the meaning of the terms in the claims may be ascertainable by reference to the description." 37 CFR 1.75(d)(1).

415 F.3d at 1316, 75 USPQ2d at 1329. See also< *In re Hyatt*, 211 F.3d 1367, 1372, 54 USPQ2d 1664, 1667 (Fed. Cir. 2000). Applicant always has the opportunity to amend the claims during prosecution, and broad interpretation by the examiner reduces the possibility that the claim, once issued, will be interpreted more broadly than is justified. *In re Prater*, 415 F.2d 1393, 1404-05, 162 USPQ 541, 550-51 (CCPA 1969) (Claim 9 was directed to a process of analyzing data generated by mass spectrographic analysis of a gas. The process comprised selecting the data to be analyzed by subjecting the data to a mathematical manipulation. The examiner made rejections under 35 U.S.C. 101 and 102. In the 35 U.S.C. 102 rejection, the examiner explained that the claim was anticipated by a mental process augmented by pencil and paper markings. The court agreed that the claim was not limited to using a machine to carry out the process since the claim did not explicitly set forth the machine. The court explained that "reading a claim in light of the specification, to thereby interpret limitations explicitly recited in the claim, is a quite different thing from 'reading limitations of the specification into a claim,' to thereby narrow the scope of the claim by implicitly adding disclosed limitations which have no express basis in the claim." The court found that applicant was advocating the latter, i.e., the impermissible importation of subject matter from the specification into the claim.). See also *In re Morris,* 127 F.3d 1048, 1054-55, 44 USPQ2d 1023, 1027-28 (Fed. Cir. 1997) (The court held that the PTO is not required, in the course of prosecution, to interpret claims in applications in the same manner as a court would interpret claims in an infringement suit. Rather, the "PTO applies to verbiage of the proposed claims the broadest reasonable meaning of the words in their ordinary usage as they would be understood by one of ordinary skill in the art, taking into account whatever enlightenment by way of definitions or otherwise that may be afforded by the written description contained in applicant's specification.").

The broadest reasonable interpretation of the claims must also be consistent with the interpretation that those skilled in the art would reach. *In re Cortright,* 165 F.3d 1353, 1359, 49 USPQ2d 1464, 1468 (Fed. Cir. 1999) (The Board's construction of the claim limitation "restore hair growth" as requiring the hair to be returned to its original state was held to be an incorrect interpretation of the limitation. The court held that, consistent with applicant's disclosure and the disclosure of three patents from analogous arts using the same phrase to require only some increase in hair growth, one of ordinary skill would construe "restore hair growth" to mean that the claimed method increases the amount of hair grown on the scalp, but does not necessarily produce a full head of hair.).

## 2111.01 Plain Meaning [R-5]

### I. THE WORDS OF A CLAIM MUST BE GIVEN THEIR "PLAIN MEANING" UNLESS **>SUCH MEANING IS INCONSISTENT WITH< THE SPECIFICATION

**>Although< claims of <u>issued</u> patents are interpreted in light of the specification, prosecution history, prior art and other claims, this is not the mode of claim interpretation to be applied during examination. During examination, the claims must be interpreted as broadly as their terms reasonably allow. *In re American Academy of Science Tech Center*, 367 F.3d 1359, 1369, 70 USPQ2d 1827, 1834 (Fed. Cir. 2004) (The USPTO uses a different standard for construing claims than that used by district courts; during examination the USPTO must give claims their broadest reasonable interpretation >in light of the specification<.). This means that the words of the claim must be given their plain meaning unless **>the plain meaning is inconsistent with< the specification. *In re Zletz*, 893 F.2d 319, 321, 13 USPQ2d 1320, 1322 (Fed. Cir. 1989) (discussed below); *Chef America, Inc. v. Lamb-Weston, Inc.*, 358 F.3d 1371, 1372, 69 USPQ2d 1857 (Fed. Cir. 2004) (Ordinary, simple English words whose meaning is clear and unquestionable, absent any indication that their use in a particular context changes their meaning, are construed to mean exactly what they say. Thus, "heating the resulting batter-coated dough to a temperature in the range of about $400^{\circ}$F to $850^{\circ}$F" required heating the dough, rather than the air inside an oven, to the specified temperature.). **

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### II. IT IS IMPROPER TO IMPORT CLAIM LIMITATIONS FROM THE SPECIFICATION

"Though understanding the claim language may be aided by explanations contained in the written

description, it is important not to import into a claim limitations that are not part of the claim. For example, a particular embodiment appearing in the written description may not be read into a claim when the claim language is broader than the embodiment." *Superguide Corp. v. DirecTV Enterprises, Inc.*, 358 F.3d 870, 875, 69 USPQ2d 1865, 1868 (Fed. Cir. 2004). See also *Liebel-Flarsheim Co. v. Medrad Inc.*, 358 F.3d 898, 906, 69 USPQ2d 1801, 1807 (Fed. Cir. 2004)(discussing recent cases wherein the court expressly rejected the contention that if a patent describes only a single embodiment, the claims of the patent must be construed as being limited to that embodiment);< *E-Pass Techs., Inc. v. 3Com Corp.*, 343 F.3d 1364, 1369, 67 USPQ2d 1947, 1950 (Fed. Cir. 2003) ("Interpretation of descriptive statements in a patent's written description is a difficult task, as an inherent tension exists as to whether a statement is a clear lexicographic definition or a description of a preferred embodiment. The problem is to interpret claims 'in view of the specification' without unnecessarily importing limitations from the specification into the claims."); *Altiris Inc. v. Symantec Corp.*, 318 F.3d 1363, 1371, 65 USPQ2d 1865, 1869-70 (Fed. Cir. 2003) (Although the specification discussed only a single embodiment, the court held that it was improper to read a specific order of steps into method claims where, as a matter of logic or grammar, the language of the method claims did not impose a specific order on the performance of the method steps, and the specification did not directly or implicitly require a particular order). See also paragraph *>IV.<, below. **>When< an element is claimed using language falling under the scope of 35 U.S.C. 112, 6th paragraph (often broadly referred to as means or step plus function language)**, the specification must be consulted to determine the structure, material, or acts corresponding to the function recited in the claim. *In re Donaldson*, 16 F.3d 1189, 29 USPQ2d 1845 (Fed. Cir. 1994) (see MPEP § 2181- § 2186).

In *In re Zletz, supra,* the examiner and the Board had interpreted claims reading "normally solid polypropylene" and "normally solid polypropylene having a crystalline polypropylene content" as being limited to "normally solid linear high homopolymers of propylene which have a crystalline polypropylene content." The court ruled that limitations, not present in the claims, were improperly imported from the specification. See also *In re Marosi,* 710 F.2d 799, 218 USPQ 289 (Fed. Cir. 1983) ("Claims are not to be read in a vacuum, and limitations therein are to be interpreted in light of the specification in giving them their 'broadest reasonable interpretation'." 710 F.2d at 802, 218 USPQ at 292 (quoting *In re Okuzawa,* 537 F.2d 545, 548, 190 USPQ 464, 466 (CCPA 1976)) (emphasis in original). The court looked to the specification to construe "essentially free of alkali metal" as including unavoidable levels of impurities but no more.). Compare *In re Weiss,* 989 F.2d 1202, 26 USPQ2d 1885 (Fed. Cir. 1993) (unpublished decision - cannot be cited as precedent) (The claim related to an athletic shoe with cleats that "break away at a preselected level of force" and thus prevent injury to the wearer. The examiner rejected the claims over prior art teaching athletic shoes with cleats not intended to break off and rationalized that the cleats would break away given a high enough force. The court reversed the rejection stating that when interpreting a claim term which is ambiguous, such as "a preselected level of force", we must look to the specification for the meaning ascribed to that term by the inventor." The specification had defined "preselected level of force" as that level of force at which the breaking away will prevent injury to the wearer during athletic exertion.**)

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### III. < "PLAIN MEANING" REFERS TO THE ORDINARY AND CUSTOMARY MEANING GIVEN TO THE TERM BY THOSE OF ORDINARY SKILL IN THE ART

"[T]he ordinary and customary meaning of a claim term is the meaning that the term would have to a person of ordinary skill in the art in question at the time of the invention, *i.e.*, as of the effective filing date of the patent application." *Phillips v. AWH Corp.*, *>415 F.3d 1303, 1313<, 75 USPQ2d 1321>, 1326< (Fed. Cir. 2005) (*en banc*). *Sunrace Roots Enter. Co. v. SRAM Corp.*, 336 F.3d 1298, 1302, 67 USPQ2d 1438, 1441 (Fed. Cir. 2003); *Brookhill-Wilk 1, LLC v. Intuitive Surgical, Inc.*, 334 F.3d 1294, 1298 67 USPQ2d 1132, 1136 (Fed. Cir. 2003)("In the absence of an express intent to impart a novel meaning to the claim terms, the words are presumed to take on the ordinary and customary meanings attributed to them by those of ordinary skill in the art."). It is the use of the words

in the context of the written description and customarily by those skilled in the relevant art that accurately reflects both the "ordinary" and the "customary" meaning of the terms in the claims. *Ferguson Beauregard/Logic Controls v. Mega Systems*, 350 F.3d 1327, 1338, 69 USPQ2d 1001, 1009 (Fed. Cir. 2003) (Dictionary definitions were used to determine the ordinary and customary meaning of the words "normal" and "predetermine" to those skilled in the art. In construing claim terms, the general meanings gleaned from reference sources, such as dictionaries, must always be compared against the use of the terms in context, and the intrinsic record must always be consulted to identify which of the different possible dictionary meanings is most consistent with the use of the words by the inventor.); *ACTV, Inc. v. The Walt Disney Company*, 346 F.3d 1082, 1092, 68 USPQ2d 1516, 1524 (Fed. Cir. 2003) (Since there was no >express< definition given for the term "URL" in the specification, the term should be given its broadest reasonable interpretation >consistent with the intrinsic record< and take on the ordinary and customary meaning attributed to it by those of ordinary skill in the art; thus, the term "URL" was held to encompass both relative and absolute URLs.); and *E-Pass Technologies, Inc. v. 3Com Corporation*, 343 F.3d 1364, 1368, 67 USPQ2d 1947, 1949 (Fed. Cir. 2003) (Where no explicit definition for the term "electronic multi-function card" was given in the specification, this term should be given its ordinary meaning and broadest reasonable interpretation; the term should not be limited to the industry standard definition of credit card where there is no suggestion that this definition applies to the electronic multi-function card as claimed, and should not be limited to preferred embodiments in the specification.).

The ordinary and customary meaning of a term may be evidenced by a variety of sources, >including "the words of the claims themselves, the remainder of the specification, the prosecution history, and extrinsic evidence concerning relevant scientific principles, the meaning of technical terms, and the state of the art."< *Phillips v. AWH Corp.*, *>415 F.3d at 1314<, 75 USPQ2d **>at 1327.< If extrinsic reference sources, such as dictionaries, evidence more than one definition for the term, the intrinsic record must be consulted to identify which of the different possible definitions is most consistent with applicant's use of the terms. *Brookhill-Wilk 1*, 334 F. 3d at 1300, 67 USPQ2d at 1137; see also *Renishaw PLC v. Marposs Societa' per Azioni*, 158 F.3d 1243, 1250, 48 USPQ2d 1117, 1122 (Fed. Cir. 1998) ("Where there are several common meanings for a claim term, the patent disclosure serves to point away from the improper meanings and toward the proper meanings.") and *Vitronics Corp. v. Conceptronic Inc.*, 90 F.3d 1576, 1583, 39 USPQ2d 1573, 1577 (Fed. Cir. 1996) (construing the term "solder reflow temperature" to mean "peak reflow temperature" of solder rather than the "liquidus temperature" of solder in order to remain consistent with the specification.). If more than one extrinsic definition is consistent with the use of the words in the intrinsic record, the claim terms may be construed to encompass all consistent meanings. ** See *>e.g.,< *Rexnord Corp. v. Laitram Corp.*, 274 F.3d 1336, 1342, 60 USPQ2d 1851, 1854 (Fed. Cir. 2001)(explaining the court's analytical process for determining the meaning of disputed claim terms); *Toro Co. v. White Consol. Indus., Inc.*, 199 F.3d 1295, 1299, 53 USPQ2d 1065, 1067 (Fed. Cir. 1999)("[W]ords in patent claims are given their ordinary meaning in the usage of the field of the invention, unless the text of the patent makes clear that a word was used with a special meaning."). Compare *MSM Investments Co. v. Carolwood Corp.*, 259 F.3d 1335, 1339-40, 59 USPQ2d 1856, 1859-60 (Fed. Cir. 2001) (Claims directed to a method of feeding an animal a beneficial amount of methylsulfonylmethane (MSM) to enhance the animal's diet were held anticipated by prior oral administration of MSM to human patients to relieve pain. Although the ordinary meaning of "feeding" is limited to provision of food or nourishment, the broad definition of "food" in the written description warranted finding that the claimed method encompasses the use of MSM for both nutritional and pharmacological purposes.); and *Rapoport v. Dement*, 254 F.3d 1053, 1059-60, 59 USPQ2d 1215, 1219-20 (Fed. Cir. 2001) (Both intrinsic evidence and the plain meaning of the term "method for treatment of sleep apneas" supported construction of the term as being limited to treatment of the underlying sleep apnea disorder itself, and not encompassing treatment of anxiety and other secondary symptoms related to sleep apnea.).

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### IV. < APPLICANT MAY BE OWN LEXICOGRAPHER

An applicant is entitled to be his or her own lexicographer and may rebut the presumption that claim terms are to be given their ordinary and customary meaning by clearly setting forth a definition of the term that is different from its ordinary and customary meaning(s). See *In re Paulsen*, 30 F.3d 1475, 1480, 31 USPQ2d 1671, 1674 (Fed. Cir. 1994) (inventor may define specific terms used to describe invention, but must do so "with reasonable clarity, deliberateness, and precision" and, if done, must "'set out his uncommon definition in some manner within the patent disclosure' so as to give one of ordinary skill in the art notice of the change" in meaning) (quoting *Intellicall, Inc. v. Phonometrics, Inc.*, 952 F.2d 1384, 1387-88, 21 USPQ2d 1383, 1386 (Fed. Cir. 1992)). Where an explicit definition is provided by the applicant for a term, that definition will control interpretation of the term as it is used in the claim. *Toro Co. v. White Consolidated Industries Inc.*, 199 F.3d 1295, 1301, 53 USPQ2d 1065, 1069 (Fed. Cir. 1999) (meaning of words used in a claim is not construed in a "lexicographic vacuum, but in the context of the specification and drawings"). Any special meaning assigned to a term "must be sufficiently clear in the specification that any departure from common usage would be so understood by a person of experience in the field of the invention." *Multiform Desiccants Inc. v. Medzam Ltd.*, 133 F.3d 1473, 1477, 45 USPQ2d 1429, 1432 (Fed. Cir. 1998). See also *Process Control Corp. v. HydReclaim Corp.*, 190 F.3d 1350, 1357, 52 USPQ2d 1029, 1033 (Fed. Cir. 1999) and MPEP § 2173.05(a). The specification should also be relied on for more than just explicit lexicography or clear disavowal of claim scope to determine the meaning of a claim term when applicant acts as his or her own lexicographer; the meaning of a particular claim term may be defined by implication, that is, according to the usage of the term in >the< context in the specification. See *Phillips v. AWH Corp.*, *>415 F.3d 1303<, 75 USPQ2d 1321 (Fed. Cir. 2005) (*en banc*); and *Vitronics Corp. v. Conceptronic Inc.*, 90 F.3d 1576, 1583, 39 USPQ2d 1573, 1577 (Fed. Cir. 1996). Compare *Merck & Co., Inc., v. Teva Pharms. USA, Inc.*, 395 F.3d 1364, 1370, 73 USPQ2d 1641, 1646 (Fed. Cir. 2005), where the court held that patentee failed to redefine the ordinary meaning of "about" to mean "exactly" in clear enough terms to justify the counterintuitive definition of "about." ("When a patentee acts as his own lexicographer in redefining the meaning of particular claim terms away from their ordinary meaning, he must clearly express that intent in the written description.").

See also MPEP § 2173.05(a).

## 2111.02 Effect of Preamble [R-3]

The determination of whether a preamble limits a claim is made on a case-by-case basis in light of the facts in each case; there is no litmus test defining when a preamble limits the scope of a claim. *Catalina Mktg. Int'l v. Coolsavings.com, Inc.*, 289 F.3d 801, 808, 62 USPQ2d 1781, 1785 (Fed. Cir. 2002). See *id.* at 808-10, 62 USPQ2d at 1784-86 for a discussion of guideposts that have emerged from various decisions exploring the preamble's effect on claim scope, as well as a hypothetical example illustrating these principles.

"[A] claim preamble has the import that the claim as a whole suggests for it." *Bell Communications Research, Inc. v. Vitalink Communications Corp.*, 55 F.3d 615, 620, 34 USPQ2d 1816, 1820 (Fed. Cir. 1995). "If the claim preamble, when read in the context of the entire claim, recites limitations of the claim, or, if the claim preamble is 'necessary to give life, meaning, and vitality' to the claim, then the claim preamble should be construed as if in the balance of the claim." *Pitney Bowes, Inc. v. Hewlett-Packard Co.*, 182 F.3d 1298, 1305, 51 USPQ2d 1161, 1165-66 (Fed. Cir. 1999). See also *Jansen v. Rexall Sundown, Inc.*, 342 F.3d 1329, 1333, 68 USPQ2d 1154, 1158 (Fed. Cir. 2003)(In considering the effect of the preamble in a claim directed to a method of treating or preventing pernicious anemia in humans by administering a certain vitamin preparation to "a human in need thereof," the court held that the claims' recitation of a patient or a human "in need" gives life and meaning to the preamble's statement of purpose.). *Kropa v. Robie*, 187 F.2d 150, 152, 88 USPQ 478, 481 (CCPA 1951) (A preamble reciting "An abrasive article" was deemed essential to point out the invention defined by claims to an article comprising abrasive grains and a hardened binder and the process of making it. The court stated "it is only by that phrase that it

can be known that the subject matter defined by the claims is comprised as an abrasive article. Every union of substances capable *inter alia* of use as abrasive grains and a binder is not an 'abrasive article.'" Therefore, the preamble served to further define the structure of the article produced.).

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## I. < PREAMBLE STATEMENTS LIMITING STRUCTURE

Any terminology in the preamble that limits the structure of the claimed invention must be treated as a claim limitation. See, e.g., *Corning Glass Works v. Sumitomo Elec. U.S.A., Inc.*, 868 F.2d 1251, 1257, 9 USPQ2d 1962, 1966 (Fed. Cir. 1989) (The determination of whether preamble recitations are structural limitations can be resolved only on review of the entirety of the application "to gain an understanding of what the inventors actually invented and intended to encompass by the claim."); *Pac-Tec Inc. v. Amerace Corp.*, 903 F.2d 796, 801, 14 USPQ2d 1871, 1876 (Fed. Cir. 1990) (determining that preamble language that constitutes a structural limitation is actually part of the claimed invention). See also *In re Stencel*, 828 F.2d 751, 4 USPQ2d 1071 (Fed. Cir. 1987). (The claim at issue was directed to a driver for setting a joint of a threaded collar*>;< however>,< the body of the claim did not directly include the structure of the collar as part of the claimed article. The examiner did not consider the preamble, which did set forth the structure of the collar, as limiting the elaim. The court found that the collar structure could not be ignored. While the claim was not directly limited to the collar, the collar structure reeited in the preamble did limit the structure of the driver. "[T]he framework - the teachings of the prior art - against which patentability is measured is not all drivers broadly, but drivers suitable for use in combination with this collar, for the claims are so limited." Id. at 1073, 828 F.2d at 754.).

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## II. < PREAMBLE STATEMENTS RECITING PURPOSE OR INTENDED USE

The claim preamble must be read in the context of the entire claim. The determination of whether preamble recitations are structural limitations or mere statements of purpose or use "can be resolved only on review of the entirety of the [record] to gain an understanding of what the inventors actually invented and intended to encompass by the claim." *Corning Glass Works*, 868 F.2d at 1257, 9 USPQ2d at 1966. If the body of a claim fully and intrinsically sets forth all of the limitations of the claimed invention, and the preamble merely states, for example, the purpose or intended use of the invention, rather than any distinct definition of any of the claimed invention's limitations, then the preamble is not considered a limitation and is of no significance to claim construction. *Pitney Bowes, Inc. v. Hewlett-Packard Co.*, 182 F.3d 1298, 1305, 51 USPQ2d 1161, 1165 (Fed. Cir. 1999). See also *Rowe v. Dror*, 112 F.3d 473, 478, 42 USPQ2d 1550, 1553 (Fed. Cir. 1997) ("where a patentee defines a structurally complete invention in the claim body and uses the preamble only to state a purpose or intended use for the invention, the preamble is not a claim limitation"); *Kropa v. Robie*, 187 F.2d at 152, 88 USPQ2d at 480-81 (preamble is not a limitation where claim is directed to a product and the preamble merely recites a property inherent in an old product defined by the remainder of the claim); *STX LLC. v. Brine*, 211 F.3d 588, 591, 54 USPQ2d 1347, 1350 (Fed. Cir. 2000) (holding that the preamble phrase "which provides improved playing and handling characteristics" in a claim drawn to a head for a lacrosse stick was not a claim limitation). Compare *Jansen v. Rexall Sundown, Inc.*, 342 F.3d 1329, 1333-34, 68 USPQ2d 1154, 1158 (Fed. Cir. 2003) (In a claim directed to a method of treating or preventing pernicious anemia in humans by administering a certain vitamin preparation to "a human in need thereof," the court held that the preamble is not merely a statement of effect that may or may not be desired or appreciated, but rather is a statement of the intentional purpose for which the method must be performed. Thus the elaim is properly interpreted to mean that the vitamin preparation must be administered to a human with a recognized need to treat or prevent pernicious anemia.); *In re Cruciferous Sprout Litig.*, 301 F.3d 1343, 1346-48, 64 USPQ2d 1202, 1204-05 (Fed. Cir. 2002) (A claim at issue was directed to a method of preparing a food rich in glucosinolates wherein cruciferous sprouts are harvested prior to the 2-leaf stage. The court held that the preamble phrase "rich in glucosinolates" helps define the claimed invention, as evidenced by the specification and prosecution his-

tory, and thus is a limitation of the claim (although the claim was anticipated by prior art that produced sprouts inherently "rich in glucosinolates")).

During examination, statements in the preamble reciting the purpose or intended use of the claimed invention must be evaluated to determine whether the recited purpose or intended use results in a structural difference (or, in the case of process claims, manipulative difference) between the claimed invention and the prior art. If so, the recitation serves to limit the claim. See, e.g., *In re Otto*, 312 F.2d 937, 938, 136 USPQ 458, 459 (CCPA 1963) (The claims were directed to a core member for hair curlers and a process of making a core member for hair curlers. Court held that the intended use of hair curling was of no significance to the structure and process of making.); *In re Sinex*, 309 F.2d 488, 492, 135 USPQ 302, 305 (CCPA 1962) (statement of intended use in an apparatus claim did not distinguish over the prior art apparatus). If a prior art structure is capable of performing the intended use as recited in the preamble, then it meets the claim. See, e.g., *In re Schreiber*, 128 F.3d 1473, 1477, 44 USPQ2d 1429, 1431 (Fed. Cir. 1997) (anticipation rejection affirmed based on Board's factual finding that the reference dispenser (a spout disclosed as useful for purposes such as dispensing oil from an oil can) would be capable of dispensing popcorn in the manner set forth in appellant's claim 1 (a dispensing top for dispensing popcorn in a specified manner)) and cases cited therein. See also MPEP § 2112 - § 2112.02.

>However, a "preamble may provide context for claim construction, particularly, where ... that preamble's statement of intended use forms the basis for distinguishing the prior art in the patent's prosecution history." *Metabolite Labs., Inc. v. Corp. of Am. Holdings*, 370 F.3d 1354, 1358-62, 71 USPQ2d 1081, 1084-87 (Fed. Cir. 2004). The patent claim at issue was directed to a two-step method for detecting a deficiency of vitamin $B_{12}$ or folic acid, involving (i) assaying a body fluid for an "elevated level" of homocysteine, and (ii) "correlating" an "elevated" level with a vitamin deficiency. 370 F.3d at 1358-59, 71 USPQ2d at 1084. The court stated that the disputed claim term "correlating" can include comparing with either an unelevated level or elevated level, as opposed to only an elevated level because adding the "correlating" step in the claim during prosecution to overcome prior art tied the preamble directly to the "correlating" step. 370 F.3d at 1362, 71 USPQ2d at 1087. The recitation of the intended use of "detecting" a vitamin deficiency in the preamble rendered the claimed invention a method for "detecting," and, thus, was not limited to detecting "elevated" levels. *Id.*

See also *Catalina Mktg. Int'l v. Coolsavings.com, Inc.*, 289 F.3d at 808-09, 62 USPQ2d at 1785 ("[C]lear rcliance on the preamble during prosecution to distinguish the claimed invention from the prior art transforms the preamble into a claim limitation because such reliance indicates use of the preamble to define, in part, the claimed invention.... Without such reliance, however, a preamble generally is not limiting when the claim body deseribes a structurally complete invention such that deletion of the preamble phrase does not affect the structure or steps of the claimed invention." Consequently, "preamble language merely extolling benefits or features of the claimed invention does not limit the claim scope without clear reliance on those benefits or features as patentably significant."). In *Poly-America LP v. GSE Lining Tech. Inc.*, 383 F.3d 1303, 1310, 72 USPQ2d 1685, 1689 (Fed. Cir. 2004), the court stated that "a '[r]eview of the entirety of the '047 patent reveals that the preamble language relating to 'blown-film' does not state a purpose or an intended use of the invention, but rather discloses a fundamental characteristic of the claimed invention that is properly construed as a limitation of the claim....'" Compare *Intirtool, Ltd. v. Texar Corp.*, 369 F.3d 1289, 1294-96, 70 USPQ2d 1780, 1783-84 (Fed. Cir. 2004) (holding that the preamble of a patent claim directed to a "hand-held punch pliers for simultaneously punching and eonnecting overlapping sheet metal" was not a limitation of the claim because (i) the body of the claim described a "structurally complete invention" without the preamble, and (ii) statements in prosecution history referring to "punching and connecting" function of invention did not constitute "clear reliance" on the preamble needed to make the preamble a limitation).<

## 2111.03 Transitional Phrases [R-3]

The transitional phrases "comprising", "consisting essentially of" and "consisting of" define the scope of a claim with respect to what unrecited additional components or steps, if any, are excluded from the scope of the claim.

The transitional term "comprising", which is synonymous with "including," "containing," or "characterized by," is inclusive or open-ended and does not exclude additional, unrecited elements or method steps. See, e.g., >*Mars Inc. v. H.J. Heinz Co.*, 377 F.3d 1369, 1376, 71 USPQ2d 1837, 1843 (Fed. Cir. 2004) ("like the term 'comprising,' the terms 'containing' and 'mixture' are open-ended.").< *Invitrogen Corp. v. Biocrest Mfg., L.P.*, 327 F.3d 1364, 1368, 66 USPQ2d 1631, 1634 (Fed. Cir. 2003) ("The transition 'comprising' in a method claim indicates that the claim is open-ended and allows for additional steps."); *Genentech, Inc. v. Chiron Corp.*, 112 F.3d 495, 501, 42 USPQ2d 1608, 1613 (Fed. Cir. 1997) ("Comprising" is a term of art used in claim language which means that the named elements are essential, but other elements may be added and still form a construct within the scope of the claim.); *Moleculon Research Corp. v. CBS, Inc.*, 793 F.2d 1261, 229 USPQ 805 (Fed. Cir. 1986); *In re Baxter*, 656 F.2d 679, 686, 210 USPQ 795, 803 (CCPA 1981); *Ex parte Davis*, 80 USPQ 448, 450 (Bd. App. 1948) ("comprising" leaves "the claim open for the inclusion of unspecified ingredients even in major amounts"). >In *Gillette Co. v. Energizer Holdings Inc.*, 405 F.3d 1367, 1371-73, 74 USPQ2d 1586, 1589-91 (Fed. Cir. 2005), the court held that a claim to "a safety razor blade unit comprising a guard, a cap, and a group of first, second, and third blades" encompasses razors with more than three blades because the transitional phrase "comprising" in the preamble and the phrase "group of" are presumptively open-ended. "The word 'comprising' transitioning from the preamble to the body signals that the entire claim is presumptively open-ended." *Id.* In contrast, the court noted the phrase "group consisting of" is a closed term, which is often used in claim drafting to signal a "Markush group" that is by its nature closed. *Id.* The court also emphasized that reference to "first," "second," and "third" blades in the claim was not used to show a serial or numerical limitation but instead was used to distinguish or identify the various members of the group. *Id.*<

The transitional phrase "consisting of" excludes any element, step, or ingredient not specified in the claim. *In re Gray*, 53 F.2d 520, 11 USPQ 255 (CCPA 1931); *Ex parte Davis*, 80 USPQ 448, 450 (Bd. App. 1948) ("consisting of" defined as "closing the claim to the inclusion of materials other than those recited except for impurities ordinarily associated therewith."). But see *Norian Corp. v. Stryker Corp.*, 363 F.3d 1321, 1331-32, 70 USPQ2d 1508, 1516 (Fed. Cir. 2004) (holding that a bone repair kit "consisting of" claimed chemicals was infringed by a bone repair kit including a spatula in addition to the claimed chemicals because the presence of the spatula was unrelated to the claimed invention). A claim which depends from a claim which "consists of" the recited elements or steps cannot add an element or step. When the phrase "consists of" appears in a clause of the body of a claim, rather than immediately following the preamble, it limits only the element set forth in that clause; other elements are not excluded from the claim as a whole. *Mannesmann Demag Corp. v. Engineered Metal Products Co.,* 793 F.2d 1279, 230 USPQ 45 (Fed. Cir. 1986). >See also *In re Crish*, 393 F.3d 1253, 73 USPQ2d 1364 (Fed. Cir. 2004) (The claims at issue "related to purified DNA molecules having promoter activity for the human involucrin gene (hINV)." *Id.*, 73 USPQ2d at 1365. In determining the scope of applicant's claims directed to "a purified oligonucleotide comprising at least a portion of the nucleotide sequence of SEQ ID NO:1 wherein said portion consists of the nucleotide sequence from … to 2473 of SEQ ID NO:1, and wherein said portion of the nucleotide sequence of SEQ ID NO:1 has promoter activity," the court stated that the use of "consists" in the body of the claims did not limit the open-ended "comprising" language in the claims (emphases added). *Id.* at 1257, 73 USPQ2d at 1367. The court held that the claimed promoter sequence designated as SEQ ID NO:1 was obtained by sequencing the same prior art plasmid and was therefore anticipated by the prior art plasmid which necessarily possessed the same DNA sequence as the claimed oligonucleotides. *Id.* at 1256 and 1259, 73 USPQ2d at 1366 and 1369.The court affirmed the Board's interpretation that the transition phrase "consists" did not limit the claims to only the recited numbered nucleotide sequences of SEQ ID NO:1 and that "the transition language 'comprising' allowed the claims to cover the entire involucrin gene plus other portions of the plasmid, as long as the gene contained the specific portions of SEQ ID NO:1 recited by the claim[s]" *Id.* at 1256, 73 USPQ2d at 1366.<

The transitional phrase "consisting essentially of" limits the scope of a claim to the specified materials

or steps "and those that do not materially affect the basic and novel characteristic(s)" of the claimed invention. *In re Herz*, 537 F.2d 549, 551-52, 190 USPQ 461, 463 (CCPA 1976) (emphasis in original) (Prior art hydraulic fluid required a dispersant which appellants argued was excluded from claims limited to a functional fluid "consisting essentially of" certain components. In finding the claims did not exclude the prior art dispersant, the court noted that appellants' specification indicated the claimed composition can contain any well-known additive such as a dispersant, and there was no evidence that the presence of a dispersant would materially affect the basic and novel characteristic of the claimed invention. The prior art composition had the same basic and novel characteristic (increased oxidation resistance) as well as additional enhanced detergent and dispersant characteristics.). "A 'consisting essentially of' claim occupies a middle ground between closed claims that are written in a 'consisting of' format and fully open claims that are drafted in a 'comprising' format." *PPG Industries v. Guardian Industries*, 156 F.3d 1351, 1354, 48 USPQ2d 1351, 1353-54 (Fed. Cir. 1998). See also *Atlas Powder v. E.I. duPont de Nemours & Co.,* 750 F.2d 1569, 224 USPQ 409 (Fed. Cir. 1984); *In re Janakirama-Rao*, 317 F.2d 951, 137 USPQ 893 (CCPA 1963); *Water Technologies Corp. vs. Calco, Ltd.,* 850 F.2d 660, 7 USPQ2d 1097 (Fed. Cir. 1988). For the purposes of searching for and applying prior art under 35 U.S.C. 102 and 103, absent a clear indication in the specification or claims of what the basic and novel characteristics actually are, "consisting essentially of" will be construed as equivalent to "comprising." See, e.g., *PPG*, 156 F.3d at 1355, 48 USPQ2d at 1355 ("PPG could have defined the scope of the phrase 'consisting essentially of' for purposes of its patent by making clear in its specification what it regarded as constituting a material change in the basic and novel characteristics of the invention."). See also *AK Steel Corp. v. Sollac*, 344 F.3d 1234, 1240-41, 68 USPQ2d 1280, 1283-84 (Fed. Cir. 2003) (Applicant's statement in the specification that "silicon contents in the coating metal should not exceed about 0.5% by weight" along with a discussion of the deleterious effects of silicon provided basis to conclude that silicon in excess of 0.5% by weight would materially alter the basic and novel properties of the invention. Thus, "consisting essentially of" as recited in the preamble was interpreted to permit no more than 0.5% by weight of silicon in the aluminum coating.); *In re Janakirama-Rao*, 317 F.2d 951, 954, 137 USPQ 893, 895-96 (CCPA 1963). If an applicant contends that additional steps or materials in the prior art are excluded by the recitation of "consisting essentially of," applicant has the burden of showing that the introduction of additional steps or components would materially change the characteristics of applicant's invention. *In re De Lajarte*, 337 F.2d 870, 143 USPQ 256 (CCPA 1964). See also *Ex parte Hoffman*, 12 USPQ2d 1061, 1063-64 (Bd. Pat. App. & Inter. 1989) ("Although 'consisting essentially of' is typically used and defined in the context of compositions of matter, we find nothing intrinsically wrong with the use of such language as a modifier of method steps. . . [rendering] the claim open only for the inclusion of steps which do not materially affect the basic and novel characteristics of the claimed method. To determine the steps included versus excluded the claim must be read in light of the specification. . . . [I]t is an applicant's burden to establish that a step practiced in a prior art method is excluded from his claims by 'consisting essentially of' language.").

### OTHER TRANSITIONAL PHRASES

Transitional phrases such as "having" must be interpreted in light of the specification to determine whether open or closed claim language is intended. See, e.g., *Lampi Corp. v. American Power Products Inc.*, 228 F.3d 1365, 1376, 56 USPQ2d 1445, 1453 (Fed. Cir. 2000) (The term "having" was interpreted as open terminology, allowing the inclusion of other components in addition to those recited); *Crystal Semiconductor Corp. v. TriTech Microelectronics Int'l Inc.*, 246 F.3d 1336, 1348, 57 USPQ2d 1953, 1959 (Fed. Cir. 2001) (term "having" in transitional phrase "does not create a presumption that the body of the claim is open"); *Regents of the Univ. of Cal. v. Eli Lilly & Co.*, 119 F.3d 1559, 1573, 43 USPQ2d 1398, 1410 (Fed. Cir. 1997) (In the context of a cDNA having a sequence coding for human PI, the term "having" still permitted inclusion of other moieties.). The transitional phrase "composed of" has been interpreted in the same manner as either "consisting of" or "consisting essentially of," depending on the facts of the particular case. See *AFG Indus-*

*tries, Inc. v. Cardinal IG Company*, 239 F.3d 1239, 1245, 57 USPQ2d 1776, 1780-81 (Fed. Cir. 2001) (based on specification and other evidence, "composed of" interpreted in same manner as "consisting essentially of"); *In re Bertsch*, 132 F.2d 1014, 1019-20, 56 USPQ 379, 384 (CCPA 1942) ("Composed of" interpreted in same manner as "consisting of"; however, court further remarked that "the words 'composed of' may under certain circumstances be given, in patent law, a broader meaning than 'consisting of.'").

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## 2111.04 "Adapted to," "Adapted for," "Wherein," and "Whereby" Clauses [R-3]

Claim scope is not limited by claim language that suggests or makes optional but does not require steps to be performed, or by claim language that does not limit a claim to a particular structure. However, examples of claim language, although not exhaustive, that may raise a question as to the limiting effect of the language in a claim are:

(A) "adapted to" or "adapted for" clauses;

(B) "wherein" clauses; and

(C) "whereby" clauses.

The determination of whether each of these clauses is a limitation in a claim depends on the specific facts of the case. In *Hoffer v. Microsoft Corp.*, 405 F.3d 1326, 1329, 74 USPQ2d 1481, 1483 (Fed. Cir. 2005), the court held that when a "'whereby' clause states a condition that is material to patentability, it cannot be ignored in order to change the substance of the invention." *Id.* However, the court noted (quoting *Minton v. Nat'l Ass'n of Securities Dealers, Inc.*, 336 F.3d 1373, 1381, 67 USPQ2d 1614, 1620 (Fed. Cir. 2003)) that a "'whereby clause in a method claim is not given weight when it simply expresses the intended result of a process step positively recited.'" *Id.*<

## 2112 Requirements of Rejection Based on Inherency; Burden of Proof [R-3]

The express, implicit, and inherent disclosures of a prior art reference may be relied upon in the rejection of claims under 35 U.S.C. 102 or 103. "The inherent teaching of a prior art reference, a question of fact, arises both in the context of anticipation and obviousness." *In re Napier*, 55 F.3d 610, 613, 34 USPQ2d 1782, 1784 (Fed. Cir. 1995) (affirmed a 35 U.S.C. 103 rejection based in part on inherent disclosure in one of the references). See also *In re Grasselli*, 713 F.2d 731, 739, 218 USPQ 769, 775 (Fed. Cir. 1983).

### I. SOMETHING WHICH IS OLD DOES NOT BECOME PATENTABLE UPON THE DISCOVERY OF A NEW PROPERTY

"[T]he discovery of a previously unappreciated property of a prior art composition, or of a scientific explanation for the prior art's functioning, does not render the old composition patentably new to the discoverer." *Atlas Powder Co. v. Ireco Inc.*, 190 F.3d 1342, 1347, 51 USPQ2d 1943, 1947 (Fed. Cir. 1999). Thus the claiming of a new use, new function or unknown property which is inherently present in the prior art does not necessarily make the claim patentable. *In re Best*, 562 F.2d 1252, 1254, 195 USPQ 430, 433 (CCPA 1977). >In *In re Crish*, 393 F.3d 1253, 1258, 73 USPQ2d 1364, 1368 (Fed. Cir. 2004), the court held that the claimed promoter sequence obtained by sequencing a prior art plasmid that was not previously sequenced was anticipated by the prior art plasmid which necessarily possessed the same DNA sequence as the claimed oligonucleotides. The court stated that "just as the discovery of properties of a known material does not make it novel, the identification and characterization of a prior art material also does not make it novel." *Id.*< See also MPEP § 2112.01 with regard to inherency and product-by-process claims and MPEP § 2141.02 with regard to inherency and rejections under 35 U.S.C. 103.

### II. INHERENT FEATURE NEED NOT BE RECOGNIZED AT THE TIME OF THE INVENTION

There is no requirement that a person of ordinary skill in the art would have recognized the inherent disclosure *at the time of invention*, but only that the subject matter is in fact inherent in the prior art reference. *Schering Corp. v. Geneva Pharm. Inc.*, 339 F.3d 1373, 1377, 67 USPQ2d 1664, 1668 (Fed. Cir. 2003) (rejecting the contention that inherent anticipation requires recognition by a person of ordinary skill in the art before the critical date and allow-